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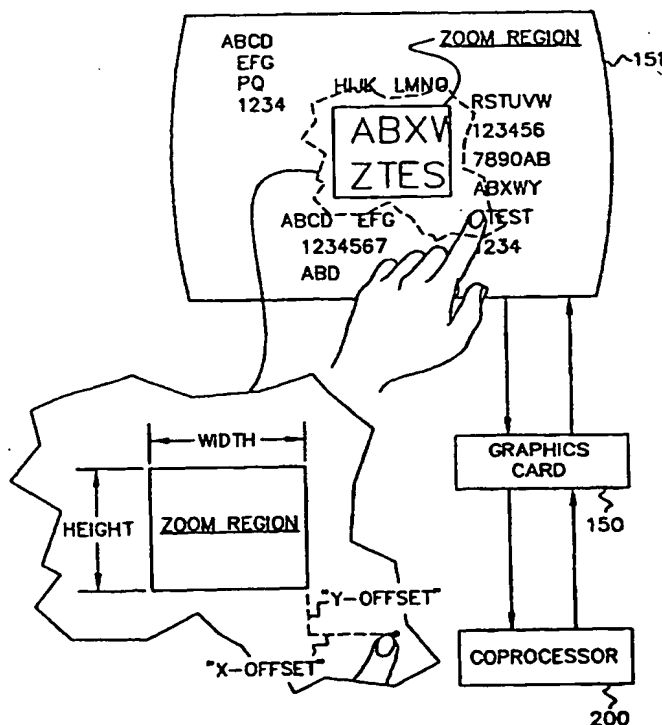
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(54) Title: A METHOD FOR UTILIZING A LOW RESOLUTION TOUCH SCREEN SYSTEM IN A HIGH RESOLUTION GRAPHICS ENVIRONMENT

(57) Abstract

A relatively low resolution touch screen system is utilized in a graphic display environment wherein the resolution of the graphic display is relatively high. The character resolution yields a low target resolution, a single character being the target (or the desired character). The method zooms a predetermined number of characters around an initially reported position into a zoom window, the zoom window being an area of the display screen relative to the initially reported position, the center of the zoom window displaying a cursor character. The zooming increases the character resolution such that target resolution is decreased to a value resulting in a touch screen resolution at least equal to or higher than resolution of the target resolution. Further, as the stylus is moved toward the desired character, a new center position of the data to be displayed in the zoom window is calculated, the new center position following the pointer element at a predetermined speed. When the desired character is over the cursor, the pointing element is withdrawn, the current position of the pointing element utilized to identify the position of the desired character, and thus the desired character itself.



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A METHOD FOR UTILIZING A LOW RESOLUTION TOUCH SCREEN SYSTEM IN A HIGH RESOLUTION GRAPHICS ENVIRONMENT

BACKGROUND OF THE INVENTION

5 The present invention relates to graphic display systems, and more particularly, to a method for utilizing a touch screen system having a relatively low resolution in a relatively high resolution graphics environment.

Presently, touch screen systems are utilized which allows direct information input to an information processing apparatus from a coordinate position on a display screen by pointing out a desired position on a display of a cathode ray tube (CRT) display device (or
10 some other like device). This technique is well accepted and has become the accepted standard for process operator interaction today. However, this technology utilizes a low resolution infrared LED touch screen with a resolution of 127 by 95 to select targets on a display with a resolution of 640 by 448. Even though the touch screen resolution is lower than that of the display, selecting targets was not a problem since the minimum target size
15 is 8 by 8. This results in a target resolution of 80 by 56 which is less than the resolution of the touch screen.

However, when higher resolution displays are utilized, such as a display having a 1280 by 1024 resolution for example, the resultant target resolution is 160 by 128. Thus, targets on this high resolution display cannot be selected directly with the current touch
20 screen resolution. The invention described in the related application identified above describes a system that zooms up the area around the immediate touch area. This technique works well except when the data immediately under the touch area is changing dynamically. When this situation occurs, the new data cannot be drawn because the zoomed up data covers where the new data should be drawn.

25 The present invention is an improvement to the invention identified in the related applications section above and corrects this condition.

SUMMARY OF THE INVENTION

Therefore, there is provided by the present invention, an improved method for utilizing a low resolution touch screen with a high resolution graphics display. A method
30 of the present invention selects a character being displayed on a display using a pointer element. The display has a first resolution and a touch screen system associated with the display has a second resolution. The character has a third resolution resulting in a target resolution, such that the target resolution is higher than the resolution of the touch screen

system. The touch screen system transmits to a data processing unit processing the display, an X and Y coordinate signal of the character pointed to. The method comprising the steps of, when a character is pointed to, accepting an initial X and Y coordinate value from the touch screen system, and calculating a corresponding X and Y coordinate value of the display. Then the initial X and Y coordinate values and the corresponding calculated X and Y coordinate values are saved. The display is zoomed a predetermined number of characters around the initial X and Y coordinate values into a zoom window, the zoom window having a predetermined size and having a predetermined location relative to an initial entry point of the pointer element. If the character to be selected is not over a cursor, the cursor being displayed in the center of the zoom window, the pointer element is moved towards the character to be selected, otherwise the pointer is withdrawn. Updated X and Y coordinate position values of the pointer element is continually accepted on a periodic basis. A new center point of the display in the zoom window is calculated, the new center point following the pointer element at a predetermined speed with respect to the speed of the pointer element. Zoomed display data around the new center point is displayed in the zoom window. The pointer is moved towards the character to be selected and the method is repeated until the character to be selected is in the center of the zoom window, i.e., in proximity or coincident with the cursor. Then the pointer element is withdrawn, the new center point calculated previously having the X and Y coordinate values of the character to be selected, thereby permitting a desired character to be selected when the target resolution is higher than the resolution of the touch screen system.

Accordingly, it is an object of the present invention to provide a method for utilizing a low resolution touch screen with a high resolution graphics display.

It is another object of the present invention to provide a method for utilizing a low resolution touch screen to select a character of a display whereby the display has a relatively high resolution.

It is still another object of the present invention to provide an improved method for utilizing a low resolution touch screen to select a character of a display, the display having a relatively high resolution, such that dynamically changing data within the zoomed area is displayed.

These and other objects of the present invention will become more apparent when taken in conjunction with the following description and attached drawings, wherein like characters indicate like parts, and which drawings form a part of the present application.

BRIEF DESCRIPTION OF THE DRAWINGS

5 Figure 1 shows a block diagram of a process control system of the preferred embodiment in which the present invention is utilized;

 Figure 2 shows a block diagram of common elements of each physical module of the process control system of Figure 1;

10 Figure 3 shows a functional block diagram of a typical physical module of the process control system;

 Figure 4 shows a partial, functional block diagram of the existing system and the opened system of the preferred embodiment;

 Figure 5 shows a functional block diagram of an open operator station of the preferred embodiment;

15 Figure 6 shows a block diagram of a graphics card of the preferred embodiment of the universal station;

 Figure 7, which comprises Figures 7A and 7B, shows examples of screen displays of the display unit of the process control system;

20 Figure 8 shows an overview of the operation of the method of the present invention;

 Figure 9, (which comprises Figure 9A and 9B,) shows a flow diagram of the logic of the graphics card 150 for implementing the method of the present invention;

 Figure 10 shows an example of display in the zoom window which follows the stylus (or pointer) at half speed (or half distance);

25 Figure 11, which comprises Figures 11A and 11B, shows a flow diagram of the event handler logic of a co-processor of the open operator station of the preferred embodiment of the present invention;

 Figure 12 shows a partial display screen showing a partial row of characters with the corresponding display pixel value and beam of the touch screen system; and

30 Figure 13 shows a partial expanded character display of Figure 12 according to the method of the present invention.

DETAILED DESCRIPTION

Before describing the method of the present invention, it will be helpful in understanding a system environment in which the invention is utilized. Referring to Figure 1, there is shown a block diagram of a process control system 10 of the preferred embodiment in which the present invention can be found. The process control system 10 includes a plant control network 11, and connected thereto is a data highway 12, which permits a process controller 20' to be connected thereto. In the present day process control system 10, additional process controllers 20' can be operatively connected to the plant control network 11 via a corresponding highway gateway 601 and a corresponding data highway 12. A process controller 20, an interface apparatus which includes many new, additions, improvements, and features over the process controller 20', is operatively connected to the plant control network 11 via a universal control network (UCN) 14 to a network interface module (NIM) 602. In the preferred embodiment of the process control system 10, additional process controllers 20 can be operatively connected to the plant control network 11 via a corresponding UCN 14 and a corresponding NIM 602. The process controllers 20, 20' interface the analog input and output signals, and digital input and output signals (A/I, A/O, D/I, and D/O respectively) to the process control system 10 from the variety of field devices (not shown) of the process being controlled which include valves, pressure switches, pressure gauges, thermocouples,....

The plant control network (or more simply network) 11 provides the overall supervision of the controlled process, in conjunction with the plant operator, and obtains all the information needed to perform the supervisory function, and includes an interface with the operator. The plant control network 11 includes a plurality of physical modules, which include a universal operator station (US) 122, an application module (AM) 124, a history module (HM) 126, a computer module (CM) 128, and duplicates (backup or secondary) of these modules (and additional types of modules, not shown) as necessary to perform the required control/supervisory function of the process being controlled. Each of these physical modules is operatively connected to a local control network (LCN) 120 which permits each of these modules to communicate with each other as necessary. The NIM 602 and HG 601 provide an interface between the LCN 120 and the UCN 14, and the LCN 120 and the data highway 12, respectively.

Physical modules 122, 124, 126, 128,... of network 11 of the preferred embodiment are of various specialized functional types. Each physical module is the peer, or equivalent, of the other in terms of right of access to the network's communication medium, or LCN 120, for the purpose of transmitting data to other physical modules of network 11.

Universal operator station module (US) 122 of network 11 is a work station for one or more plant operators. It includes an operator console which is the interface between the plant operator, or operators, and the process or processes of the plant for which they are responsible. Each universal operator station module 122, is connected to the LCN 120, and all communications between the universal operator station module 122, and any other physical module of network 11, is via the LCN 120. Universal operator station module 122 has access to data that is on the LCN 120 and the resources and data available through, or from, any of the other physical modules of network 11. The universal station module 122 includes a cathode ray tube display (CRT) (not shown) which includes a video display generator, an operator keyboard (KB) (not shown), a printer (PRT) (not shown), and can also include (but not shown) a cartridge disk data storage device, trend pen recorders, and status displays, for example.

A history module (HM) 126 provides mass data storage capability. The history module 126 includes at least one conventional disk mass storage device such as a Winchester disk, which disk storage device provides a large volume of nonvolatile storage capability for binary data. The types of data stored by such a mass storage device are typically trend histories, event histories,or data from which such histories can be determined, data that constitutes or forms CRT type displays, copies of programs for the physical modules....

An application module (AM) 124 provides additional data processing capability in support of the process control functions performed by the controllers associated with the process control subsystem 20, 20' such as data acquisition, alarming, batch history collection, and provide continuous control computational facilities when needed. The data processing capability of the application module 124 is provided by a processor (not shown) and a memory (not shown) associated with the module.

Computer module (CM) 128 uses the standard or common units of all physical modules to permit a medium-to-large scale, general purpose data processing system to

communicate with other physical modules of network 11 and the units of such modules over the LCN 120 and the units of process control subsystems 20, 20' via the highway gateway module 601, and the NIM 602, respectively. Data processing systems of a computer module 128 are used to provide supervisory, optimization, generalized user
5 program preparation and execution of such programs in higher level program languages. Typically, the data processing systems of a computer module 128 have the capability of communicating with other such systems by a communication processor and communication lines.

The local control network 120 (LCN) is a high-speed, bit serial, dual redundant
10 communication network that interconnects all the physical modules of plant control network 11. LCN 120 provides the only data transfer path between the principal sources of data, such as highway gateway module 601, application module 124, and history module 126, and principal users of such data, such as universal operator station module 122, computer module 128, and application module 124. LCN 120 also provides the
15 communication medium over which large blocks of data, such as memory images, can be moved from one physical module such as history module 126 to universal station module 122. LCN 120 is dual redundant in that it consists of two coaxial cables that permit the serial transmission of binary signals over both cables.

Referring to Figure 2, there is shown a block diagram of the common elements of
20 each physical module of the network 11 or the process control system 10. Each of the physical modules includes a module central processor unit 38 and a module memory 40, a random-access memory (not shown), and such additional controller devices, or units (not shown), which are configured to provide the desired functionality of that type of module, i.e., that of the operator station 122, for example. The data-
25 processing capabilities of each module's CPU 38 and module memory 40 create a distributed processing environment which provides for improved reliability and performance of network 11 and process control system 10. The reliability of network 11 and system 10 is improved because, if one physical module of network 11 fails the other physical modules will remain operational. As a result, network 11 as a whole is not
30 disabled by such an occurrence as would be the case in centralized systems. Performance is improved by this distributed environment in that throughput and fast operator response

times result from the increase computer processing resources, and the concurrency and parallelism of the data-processing capabilities of the system.

As mentioned above, each physical module includes the bus interface unit, BIU, 32 which is connected to the LCN 120 by the transceiver 34. Each physical module is also provided with the module bus 36 which, in the preferred embodiment, is capable of transmitting 16 bits of data in parallel, between the module CPU 38 and the module memory 40. Other units, utilized to tailor each type of physical module to satisfy its functional requirements, are operatively connected to module bus 36 so that each such unit can communicate with the other units of the physical module via its module bus 36. The BIU 32 of the physical module initiates the transmission of data over LCN 120. In the preferred embodiment, all transmissions by a BIU 32 are transmitted over the coaxial cables which, in the preferred embodiment, form the LCN 120.

Referring to Figure 3 there is shown a functional block diagram of a typical physical module 122, 124, 126, 128 of the plant control network 11, and includes the bus interface unit (BIU) 32 and the transceiver 34, which connects BIU 32 to the LCN 120. BIU 32 is capable of transmitting binary data over LCN 120 and of receiving data from LCN 120. Transceiver 34 in the preferred embodiment, is transformer coupled to the LCN 120. In the preferred embodiment, the LCN 120 is a dually redundant coaxial cable with the capability of transmitting bit serial data. BIU 32 is provided with a very fast micro-engine 56. In the preferred embodiment, micro engine 56 is made up of bit slice components so that it can process eight bits in parallel, and can execute a 24 bit microinstruction from its programmable read only memory (PROM) 58.

Signals received from the LCN 120 are transmitted by transceiver 34 and receive circuitry 52 to receive FIFO register 54. Micro engine 56 examines the data stored in FIFO register 54 and determines if the information is addressed to the physical module. If the data is an information frame, the received data is transferred by direct memory access (DMA) write circuitry 66 by conventional direct memory access techniques to the physical module memory unit (MMU) 40 over module bus 36.

Communication between MCPU processor 68, a Motorola 68020 microprocessor in the preferred embodiment, and other functional elements of MCPU 38 is via local microprocessor bus 39. Module bus interface element 41 provides the communication link between local bus 39 and module bus 36. Processor 68 executes instructions fetched

from either its local memory 43, in the preferred embodiment an EPROM, or from MMU 40. Processor 68 has a crystal controlled clock 45 which produces clock pulses, or timing signals. Input/output (I/O) port 49 provides communication between MCPU 38 and equipment external to the physical module to permit program loading, and the diagnosis of errors, or faults, for example.

Each MCPU 38 includes a timing subsystem 48 which, in response to clock signals from module clock 45 produces fine resolution, synchronization, and real-time, timing signals. Any timing subsystem 48 which is provided with a timing subsystem driver 50, has the capability of transmitting timing information to other physical modules over the LCN 120. Another input to each timing subsystem 48, is timing information which is transmitted over LCN 120 and which is received through transceiver 34, timing receiver 55 and timing driver 57 of BIU 32. Timing pulses from module power supply 59 which are a function of the frequency of the external source of A.C. electric power applied to power supply 59 are used by timing subsystem 48 to correct longer term frequency drift of the clock pulses produced by clock 45.

Additional information of the BIU 32 can be found in U.S. Patent No. 4,556,974. A more detailed description of the process control system 10 can be had by referring to U.S. Patent No. 4,607,256. Additional information of the individual, common, functional blocks of the physical modules can be had by reference to U.S. Patent No. 4,709,347, all of the above-identified patents being assigned to the assignee of the present application, and additional information of the process controller 20' can be had by referencing U.S. Patent No. 4,296,464.

The addition of an interface apparatus which interfaces other systems to the process control system 10 described above and a modification to a graphics generator in the US 122 opens up the existing system, specifically the graphics interface, which includes designing in the capability to readily permit nodes of differing designs to communicate to the network, and will now be described.

Referring to Figure 4, there is shown a partial functional block diagram of the existing system and the open (or opened) system. The universal operator station (US) 122 is coupled to a co-processor 200, and the co-processor is coupled to an open system, i.e., interfaces/protocols of differing design, including task control program/interface protocol (TCP/IP), open system interface (OSI), DECnet (a product of the Digital Equipment

Corporation of Maynard, Massachusetts),.... The universal station 122 is also connected to the LCN 120 as described above. Thus, the new universal operator station (open US) 123 includes the US 122 as described above in conjunction with the co-processor 200. The purpose of the open US 123 is to open the graphical interface to the open systems and to provide information from the closed US to the open systems. The co-processor 200 is structured to permit the interface to other systems, i.e., the open systems without jeopardizing the integrity of the existing system. The co-processor 200 of the preferred embodiment is a Motorola 68040 microprocessor which is executing the UNIX operating systems (UNIX is an operating system of the American Telephone and Telegraph Company, ATT, is readily available and is well known to those skilled in the art), and is sometimes referred to as a UNIX co-processor.

Referring to Figure 5, there is shown a functional block diagram of the open operator station 123 of the preferred embodiment. The operator station 122 as described above includes the BIU 32 connected to the module bus 36, the module memory 40, and the module CPU 38, both also connected to the module bus 36. These basic functional blocks are contained in all the physical modules. Additional functional blocks added to the physical module is what gives the physical module its personality apart from any other physical module. The operator station 122 includes a graphics card 150 which interfaces with a display (CRT) and a keyboard (KB) 151, 153. A shared memory 202 is included and is also connected to the module bus 36 which provides for communication between the co-processor 200 and the US physical module 122 (thereby providing communication to the rest of the process control system 10 via the module CPU 38). Thus, the co-processor 200 requests service (e.g., the value of a point, contents of a file,... or any information of the process control system 10) of the module CPU 38 through shared memory 202. The module CPU 38 then communicates with the appropriate module to perform the requested service in a normal fashion. Once the response is obtained the information is passed to the co-processor 200 via shared memory 202. Since the module CPU 38 is communicating via the LCN 120, the integrity of the LCN (i.e., the system) is maintained and similarly the module memory 40 cannot be corrupted by the co-processor 200.

Also shown in Figure 5 is an example open system (or foreign system), for example, a Digital Equipment Corporation system which includes the DECnet network

and protocol and a DEC processor 300 attached to the DECnet network. In the preferred embodiment, the communication between the DEC open system and the co-processor 200 is via an X-windows protocol (X-windows being a protocol defined by the Massachusetts Institute of Technology, Cambridge, Massachusetts) for graphical display information, and
5 other open systems standards being used for data exchange. Any requests of the outside system to the LCN is made via the co-processor 200 through the shared memory 202 to the module CPU 38 as described above.

It is also desired to open up the graphics interface such that a display which is not on the LCN can be displayed onto the CRT 151 of the US 122. This is achieved by the
10 interface to the graphic card 150 from the co-processor 200. Referring to Figure 6, there is shown a block diagram of the graphics card 150 of the preferred embodiment. The graphics card includes a card bus 152. Attached to the card bus 152 is a data memory 154 which contains the information which is to be displayed onto the CRT, and also contains some control information. A microprocessor 156 is also coupled to the card bus 152 and
15 further is coupled to the module bus 36. A graphics processor 160 is coupled to the card bus 152 and performs all the processing for developing the information stored in the data memory 154, including some control functions. A shared memory 158 is coupled to the card bus 152. A connection is made from the card bus 152 to the co-processor 200, thereby providing the interface mentioned above to the graphics card 150 from the co-
20 processor 200. The microprocessor 156 of the preferred embodiment of the graphic card 150 is a Motorola 68020 processor. The graphics card 150 is a two port graphics card, one port of the graphics card being tied to the module bus 36 which is how a display is driven from LCN. The LCN 120 provides a "single window to the process," i.e., a screen display of what the process/process control system is doing. The second port is coupled to the co-
25 processor 200 and provides the windows interface for the universal station 122. The windows interface is the X-windows interface which is well defined and well known to those skilled in the art (the interface being defined by MIT, Cambridge, Massachusetts). It is through the interface from the co-processor 200 that all the window displays [i.e., the screen display(s) of the open system(s)] and windows controls are performed, including
30 commands to the graphic card 150 to specify where to place the single window to the process on the screen of the CRT 151. The interface between the graphics card 150 and the co-processor 200 is the full windows interface. One of the windows is the display

referred to above as the "single window to the processor" (sometimes referred to as the LCN window). The co-processor 200 commands the graphics card 150 where the LCN window is to be placed on the CRT 151 and its relative size on the display. X-windows is a well defined protocol of how to communicate with the graphics card 150 (or any
5 graphics card) and display, and a computer permitting many windows to be displayed. This includes displaying at least one window from the LCN and/or at least one window from the open system 300. In this system, a server is defined in X-windows as the machine that is driving the display (or that portion of the co-processor 200 which interfaces to the graphics card 150), and a client is the application program, in the present
10 embodiment, the DEC processor 300.

The client 300 can have data which is desired to be displayed. The client 300 communicates with the server portion of the co-processor 200 through an X-windows protocol indicating data to be displayed. The server portion of the co-processor 200 communicates with the graphics card 150 through a device dependent layer (DDL) and is
15 provided by the vendor of the graphics card, or in X-windows is via DDX protocol. The microprocessor 156 maintains the integrity of the card bus 152 into the data memory 154. The processing of the data to be displayed on the CRT 151 is performed by the graphics processor 160. When a predetermined data screen is to be displayed, the microprocessor 156 (which accepts requests from the LCN 120 via module bus 36) places the data in
20 shared memory 158, and is subsequently processed by the graphics processor 160, and is then stored in data memory 154. When the open system 300 (via the client) desires to display some information, the information is communicated to the server portion of the co-processor 200 which then stores the information in the shared memory 158. The graphics processor 160 then processes that information and stores it in the data memory 154 for
25 display. In that manner, and under the control of the graphics processor 160, the plurality of displays, i.e., windows, is displayed on the CRT 151.

It will be understood by those skilled in the art that the X-window protocol is essentially the open interface standard, the X-window protocol being readily available and well known to those skilled in the art. In the preferred embodiment the UNIX operating
30 system is utilized, the UNIX operating system being able to run on many commercially available processors. Further information on the preferred embodiment of the graphics card 150 of the preferred embodiment of the US 122 can be had by reference to U.S.

Patent Numbers 4,490,797 and 4,663,619, although it will be understood that any graphics card can be utilized as discussed above. The graphics processor 160 of the preferred embodiment of the present invention is a Texas Instruments (TI) TMS 34020. The microprocessor 156 and the module CPU 38 is a Motorola 68020. The co-processor 200
5 of the preferred embodiment of the present invention is a Motorola 68040, having bus capability with the other microprocessors of the system. It will be understood that a variety of processors can be utilized including a reduced instruction set processor which is available from Hewlett Packard among other processor manufacturers.

Although the preferred embodiment utilizes the UNIX operating system, it will be
10 recognized by those skilled in the art that any operating system can be utilized, including OSF1, Open Systems Foundation/USA, Cambridge, Massachusetts. Although the co-processor 200 is controlling the display in the preferred embodiment the graphics card can also perform the display control. Since X-windows was readily available and performed the desired display control function, X-windows was utilized to take advantage of the
15 availability of the desired control function. It will be recognized by those skilled in the art that implementation of the present invention is not limited to X-windows, and that any protocol can be utilized.

Thus it can be seen that the process control system 10 is open system permitting other system to interface into the LCN of the process control system and, because of the
20 communication scheme as described above, the integrity of the process control system 10 is maintained. Further, the graphics card 150, although not in immediate control of the display unit 151, guarantees that the graphic view (control view) to a field device (i.e., valve,...) or any other controls view of the process control system on the display unit is always maintained regardless of the operational state of the co-processor 200. If the co-processor 200 is running and controlling the display unit 151 (and in particular the actual
25 display on the screen of the display unit 151) and a malfunction occurs or some other anomaly occurs to the co-processor 200, the function of the graphics card 150 guarantees that a single view of the process control system is maintained. As discussed above, the co-processor is connected into the US 122 and has and controls a graphical interface through
30 the display 151 and keyboard 153.

Referring to Figure 7, which comprises Figures 7A and 7B, there is shown an example of two displays of the display unit 151. Figure 7A shows an example of a typical

normal display and Figure 7B shows a display when an anomaly occurs with the co-processor 200, or the fallback display. Figure 7A shows, for example, the windows which can be displayed. The windows always include a "view of the process", i.e., a control view from the process control system 10. Also included can be, for example, a window showing event history (a process control system application) coming from an outside system, running a process control system application, for example a DEC computer system 300 as shown in Figure 5. Another window can be data coming from another outside computer system (not shown), for example such as an Apple computer. This computer system can be running another application program referred to as documentation (in the preferred embodiment of the process control system the documentation of the process control system is created on an Apple computer). Still another window can be displayed, for example, lab data, coming from a Hewlett Packard computer system. The windows, except for the control view, are displayed on a single screen of the display unit 151, the display information for these windows coming from a number of outside computer systems connected into the co-processor 200. If an error is detected with the co-processor 200, the method of the present invention guarantees that the display windows from the outside systems are inhibited and the control view is the only display shown and is zoomed to take up the entire screen of the display unit 151. This observation also serves as an indication to the operator that a malfunction has occurred with the interface to the outside systems.

The utilization of a low resolution touch screen system in a high resolution graphics environment, the method of the present invention, will now be described. The display of the preferred embodiment of the present invention has a 1280 by 1024 resolution, i.e., 1280 pixels wide by 1024 pixels high. A single character on the display is an 8 by 8 pixels character, and it is desirable to be able to position to a character. The touch screen system of the preferred embodiment of the present invention is an infrared technology having X coordinate and Y coordinate beams across the display which are broken upon pointing to a desired position of the display. The pointing can be done by a finger (a pen, pencil, stylus,...) which breaks the beams. As is well known to those skilled in the art one side of the touch screen system includes LEDs and on the opposite side sensors are placed which receive the signal from the LEDs. When the beam is broken a report is transmitted by the touch screen system to an information processing apparatus

identifying the coordinate inputs of the position desired. In order for a report to be transmitted, both an X beam and a Y beam must be broken. The present invention utilizes a touch screen having a resolution of 127 wide by 95 high. Thus for an 8 by 8 character size, a display resolution of 1280 by 1024 has a resultant target resolution of 160 wide by 128 high. In this particular instance the target resolution is higher than the touch screen resolution, the touch screen resolution being 127 by 95. Thus the desired objective of being able to position to a character cannot be met.

In order to be able to achieve the desired objective of positioning to a single character, the display is zoomed in a predefined "window area" off to the side of the finger (or stylus) thereby permitting new data around the zoomed up area to be drawn (displayed) and viewed. The character resolution around the reported position displayed in the window area has a character resolution of 16 by 16. This results in a target resolution of 80x64. As a result of the lower target resolution, the touch screen resolution of 127 wide by 95 high results in having at least one beam cross a character, being able to position to a desired character.

The method of the present invention is implemented in the preferred embodiment wherein the graphics card 150 (more specifically, the microprocessor 156 and the graphics processor 160), sometimes referred to herein as graphics controller, includes some logic and the co-processor 200 includes some logic (in the X-server portion of the X-windows protocol and extension of the X-server), the graphics card 150 and the co-processor 22 operating together to obtain the improved display of the present invention. Referring to Figure 8 there is shown an overview of the operation of the method of the present invention.

When a user of the open universal station 123 determines to select a target on the display 151, the operator points at that target on the face of the display 151. When this is done, the touch screen system (or more simply referred to herein as display 151) detects the touching of the display 151 and reports the x-y coordinates of that touch to the graphics card 150. The graphics card 150 then reports the touch screen coordinates to the X-server logic. Using this data the X-server logic computes the zoom region (sometimes referred to herein as the predefined "window area" or "window") and notifies the graphic card 150 of the bounding region and location in which to zoom the display, and the graphics card 150 zooms up the area around the x-y touch coordinates into this zoom

window. Due to the inherent inaccuracy of the touch screen system it is likely that the initial touch position is not directly over the desired target. As a result, the operator will move the pointing device (finger, stylus, pointer,...) until the touch position is over the desired target. This results in the touch screen system sending a new x-y coordinate to the graphics card 150. When these new coordinates are received, the graphics card 150 calculates new x-y coordinates to send to the X-server logic and zooms up the area around the new x-y coordinates into the zoom window. The location of the zoom window on the display remains fixed, but the data contained within the zoom window follows the pointer as will be described in more detail hereinunder. This process continues until the pointing device is removed from the touch screen system. When the removal of the pointing device is detected, the touch screen system sends an exit code to the graphics card 150. Upon receipt of this signal, the graphics card stops zooming data into the zoom window, and passes the exit code to the X-server logic. When the X-server logic detects the exit code, it removes the zoom window and the image that was covered by the zoom window is restored.

When the server logic starts up, the zoom feature is included as part of the start up procedure by the operator. If the zoom feature is not initialized, then the touch screen zooming function is disabled. If the zoom feature is started, then a zoom window of settable size and location, i.e., programmable, is defined. The operator indicates the size of the zoom region by height and width, indicates the x-offset and y-offset, and indicates whether the operator is standing or sitting, right handed or left handed,... In this fashion the zoom window will be presented in the most unobstructed manner, i.e., the zoom window will be unobstructed from the operators view as determined by the inputted initialized information. The cursor position is defined as the center of the zoom region and is not displayed when the display is in a zoom mode. When the finger is removed and the zoom region is deleted, the cursor will appear in its proper position on the display.

Referring to Figure 9, which comprises Figures 9A and 9B, there is shown a flow diagram of the logic of the graphics card 150 for implementing the method of the present invention. When the finger (or stylus) is inserted onto the touch screen such that an X and Y beam are broken (block 410), a report is received by the information handling apparatus, in the preferred embodiment the graphics processor 160 of the process control system 10. Upon the first entry of the finger or stylus onto the display screen, the report also indicates

that this is an entry report (block 415). The graphics processor 160 checks to verify whether this is the first report (block 420) and if it is sets a first report flag (block 425). The x and y positions (T/Sx and T/Sy) from the touch screen system is accepted by the graphics processor 160 (block 430). The graphics processor calculates the actual screen x and y coordinates, ACTx and ACTy, utilizing the touch screen (T/S) positions from the touch screen systems (block 435). Actual coordinates are determined using the equations;

$$ACTx = T/Sx * 10.15$$

$$ACTy = T/Sy * 10.88.$$

These positions, i.e., the T/S positions and actual positions are saved (block 440), and the actual positions are sent to the co-processor 200 (block 440). If the zooming touch feature is disabled, the processing proceeds to block 410 (block 444). If the zooming touch feature is enabled (block 444), a "zoom up around touch" flag is set (block 445) and the processing proceeds to block 410.

A report is transmitted to the graphics processor 160 by the touch screen system about every 1/16 of a second, i.e., 16 reports per second. Since the initial report, as a result of placing the finger onto the touch screen, may not result in identifying the desired character, the finger or stylus may be moved. On each subsequent report, since the finger or stylus is still on the screen, the exit report check of block 415 will indicate a no; however, the first report determination will also be a no thus proceeding to block 446.

The graphics processor 160 determines if the zoom touch and the zoom window are enabled (blocks 446, 447). If neither are enabled, the processing proceeds to block 430. If both are enabled the process proceeds to block 450. The new area to be zoomed around as the pointer is moved is now calculated. The T/Sx, T/Sy, coordinates and accepted (block 450) and XDIFF and YDIFF coordinates are calculated as follows:

$$XDIFF = (INITIAL T/Sx - T/Xx) * 5.08$$

$$YDIFF = (INITIAL T/Sy - T/Sy) * 5.44 \text{ (block 455).}$$

The center of the screen X, Y coordinates which are to be zoomed around is calculated (block 456), and transmitted to the co-processor 200 (block 457). The processing then proceeds to block 445. The characters are zoomed to a 16 by 16 pixel size and showing approximately a 20 by 20 character (depending on the size of the programmable zoom region) around the new center position. Thus, as the finger or stylus is moved, the zoomed area follows the stylus at half the distance (or half the "speed") such

that ultimately the desired character is pointed to by the finger or stylus. An example of the half speed display of the zoomed area is shown in Figures 10A and 10B, which comprises Figure 10. Recall that in all cases the zoomed region remains fixed in location on the display screen. When the desired (or target) character is pointed to by the cursor, i.e., in the center of the zoom region, in the preferred embodiment, the finger or stylus is withdrawn.

When the finger or stylus is withdrawn, the touch screen system transmits an exit report to the graphics processor 160 and the graphics processor clears the first report flag (block 485), sends an exit code to the co-processor 200 (block 481), and checks to see if the zoom window was enabled (block 482). If the zoom window has not been enabled the processing proceeds to block 410. If the zoom window was enabled the cursor is restored (block 483), and the processing proceeds to block 410.

At block 410, the graphics processor is waiting to receive reports. If no report is received the graphics processor proceeds to determine if the zoom up around touch flag was set (block 490), shown in Figure 9B. If the flag was set the graphics processor 160 determines if the zoom window has been enabled (block 492). If neither condition is met the processing repeats itself at block 410 and is in a constant wait loop. If both conditions are met the graphics processor clears the zoom up around touch flag (block 494), obtains the zoom window parameters from the co-processor 200 (block 496), and the zoom up area around the actual screen x-y touch coordinates are placed into the zoom window (block 498). The processing then returns to block 410.

Referring to Figure 12 there is shown a partial display screen showing row 1 of characters 16 through 19. The X position pixels and Y position pixels of the display screen are also shown for the pertinent characters. The touch screen apparatus includes only the X beams (but will also apply for the Y beams although not shown). Beams 12, 13, and 14 are shown intersecting characters 16, 18, and 19. This is because the resolution of the touch screen apparatus as mentioned above is lower than the target resolution, assuming for purposes of example here that the target character is character 17. With a touch screen resolution of 127 by 95 pixels for the touch screen and a target resolution of 160 by 128, the beams can only cross approximately one out of every ten pixels. Thus for a character having 8 pixels there will be a number of characters which will not have an intersecting or crossing beam. Referring to Figure 13, there is shown a partial zoomed

area of the display of Figure 12. Generally the finger or stylus will break 2 or 3 beams, rarely 4 beams in each direction. Let's assume for purposes of example that X beams 12, 13, and are broken, character 17 being the character attempted to pointed to (i.e., the desired character). The X coordinate position for beam 13 is transmitted as the actual T/Sx coordinate value.

According to the present invention, character 18 will be the "pointed to" character such that character 18 will be zoomed to a 16 by 16 character size (including approximately 20 by 20 characters around that initial position according to the present invention). Since character 17 is the desired character, as the finger is moved towards character 17 the character will appear in the zoom region under the cursor in the zoom region. At a point in time when character 17 is on the cursor, the finger is withdrawn. The beam positions are transmitted to the processing device which calculates the x, y screen coordinates which identifies character 17. When the finger is withdrawn the display is restored to its original.

Referring to Figure 11, which comprises Figures 11A and 11B, there is shown a flow diagram of the X-server logic of co-processor 200, which operates in conjunction with the graphics card logic, to generate the display, and specifically to generate the window of the display 151, in the preferred embodiment of the present invention. Figure 11A shows the event handler of the X-server logic, including events, i.e., inputs, which are received from the open US 123 namely, keyboard inputs, mouse inputs, touch screen inputs,.... Generally, when the display is in a zoom mode, and an input is received from other than the touch screen, the zoom window is removed from the screen, and the display restored to a normal display without the window. When an event is received from the touch screen and is a coordinate event (i.e., not including the exit code), the logic of block 501 is activated. When the event is a touch screen exit code, the logic of block 511 is activated.

Referring to Figure 11B, a more detail flow chart of the touch screen event processing in co-processor 200 is shown. If the zoom feature is enabled (block 502) and the zoom window has not been mapped to the display (block 503), the window is generated. The size and position of the zoom window are determined (block 504), and the zoom window is mapped to the display (block 506). The information (i.e., parameters) of the zoom window are passed to the graphics card logic 150 (or sometimes referred to as

the graphics controller (G/C)) (block 507), and the graphics controller is informed that the zoom window is enabled (block 508). The logic then continues to block 521.

If the touch screen event includes an exit code (block 520), then the logic of block 511 is activated in which the window is removed from the display. If the zoom window is mapped to the display (block 512), the zoom window is unmapped from the display (block 514), and the graphics controller is informed that the zoom window has been disabled (block 516). Thus the zoom window is removed from the screen. If the zoom window has not been mapped to the display (block 512), the X-server logic sends the new cursor location on into the server for further processing (block 521). In this manner the X-server logic generates or removes the zoom window from the display and indicates to the graphics controller logic whether the zoom window is enabled or disabled. The graphics controller logic subsequently places the zoomed data within the zoom window in accordance with the method of the present invention described above.

It will be understood by one skilled in the art that although some of the figures show the zoom window above and to the left of the pointer, the pointer may be in other relative locations, such as above and to the right, below and to the left, below and to the right of the pointer. The location of the window relative to the pointer is programmable from the data entered by the operator as described above. Further, it will be understood by one skilled in the art that when the pointer enters the display at the upper left hand corner and the window is programmed to be above and to the left of the pointer, the logic will invert the zoom window location such that it appears on the screen, i.e., below and to the right of the pointer. Similarly when the pointer enters the display at an upper edge, the window will appear below the pointer. When the pointer enters the upper right corner of the display, the window is placed below and to the left,....

While there has been shown what is considered the preferred embodiment of the present invention, it will be manifest that many changes and modifications can be made therein without departing from the essential spirit and scope of the invention. It is intended, therefore, in the annexed claims to cover all such changes and modifications which fall within the true scope of the invention.

CLAIMS

- 1) A method for selecting a character being displayed on a display using a pointer element, wherein the display has a first resolution and a touch screen system associated with the display has a second resolution, and wherein the character has a third resolution resulting in a target resolution, and further wherein the target resolution is higher than the resolution of the touch screen system, the touch screen system transmitting to a data processing unit processing the display, an X and Y coordinate signal of the character pointed to, the method comprising the steps of:
- 5
- a) when a character is pointed to, accepting an initial X and Y coordinate value from the touch screen system, the pointer element having a current pointer location;
 - 10 b) calculating a corresponding X and Y coordinate value of the display;
 - c) saving the initial X and Y coordinate values and the corresponding calculated X and Y coordinate values;
 - d) zooming the display a predetermined number of characters around the initial X and Y coordinate values into a zoom window, the zoom window having a predetermined size and having a predetermined location relative to an initial entry point of the pointer element;
 - 15 e) if the character to be selected is not coincident with a cursor, the cursor being displayed in the center of the zoom window,
 - 20 i) moving the pointer element from the current pointer location to a new current pointer location towards the character to be selected, otherwise
 - ii) proceeding to step (j);
 - f) while the pointer element is being moved towards the character to be selected, continuing to accept updated X and Y coordinate position values of the current pointer location on a periodic basis;
 - 25 g) calculating a new center point of the display in the zoom window, the new center point following the pointer element at a predetermined distance with respect to the distance of the pointer element;
 - h) providing the predetermined number of characters around the new center point to be displayed in the zoom window;
 - 30 i) repeating the method from step (e) until the character to be selected is in the center of the zoom window; and

j) withdrawing the pointer element, the new center point calculated from step (g) having the X and Y coordinate values of the character to be selected, thereby permitting a desired character to be selected when the target resolution is higher than the resolution of the touch screen system.

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2. A method for selecting a character according to Claim 1, wherein the step of zooming comprises the step of:

zooming each character within the predetermined number of characters around the initial X and Y coordinate values wherein each of the zoomed characters has a fourth resolution, such that the resultant target resolution is less than the resolution of the touch screen system, thereby permitting a predetermined character to be selected.

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3. A method for selecting a character according to Claim 2, wherein the fourth resolution, the resolution of the zoomed characters, is twice the third resolution, the resolution of the characters displayed on the display.

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4. A method for selecting a character according to Claim 3 wherein the predetermined number of characters zoomed around the initial X and Y coordinates is 20 characters by 20 characters.

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5. A method for selecting a character according to Claim 1, wherein the step of calculating a new center point to zoom the display, generates the new center point coordinates from the current pointer location to a relative position from the initial X and Y coordinate value, the relative position being a factor less than one, such that as the pointer element is moved the desired character ultimately gets to a position in the zoomed display wherein the cursor is coincident with the desired character.

25

6. A method for selecting a character according to Claim 2, wherein the step of calculating a new center point to zoom the display, generates the new center point coordinates from the current pointer location to a relative position from the initial X and Y coordinate value, the relative position being a factor less than one, such that as the pointer

30

element is moved the desired character ultimately gets to a position in the zoom window wherein the cursor is coincident with the desired character.

- 5 7. A method for selecting a character according to Claim 5, wherein the factor used to determine the relative position of the new center point is one half.
8. A method for selecting a character according to Claim 7, wherein the predetermined size of the zoom window is programmable.
- 10 9. A method for selecting a character according to Claim 8 wherein the predetermined location of the zoom window is programmable such that the zoom window is viewable and unobstructed from view.
- 15 10. A method for selecting a character according to Claim 9 wherein the predetermined location of the zoom window remains in a fixed predetermined location as the pointer element moves over the display.

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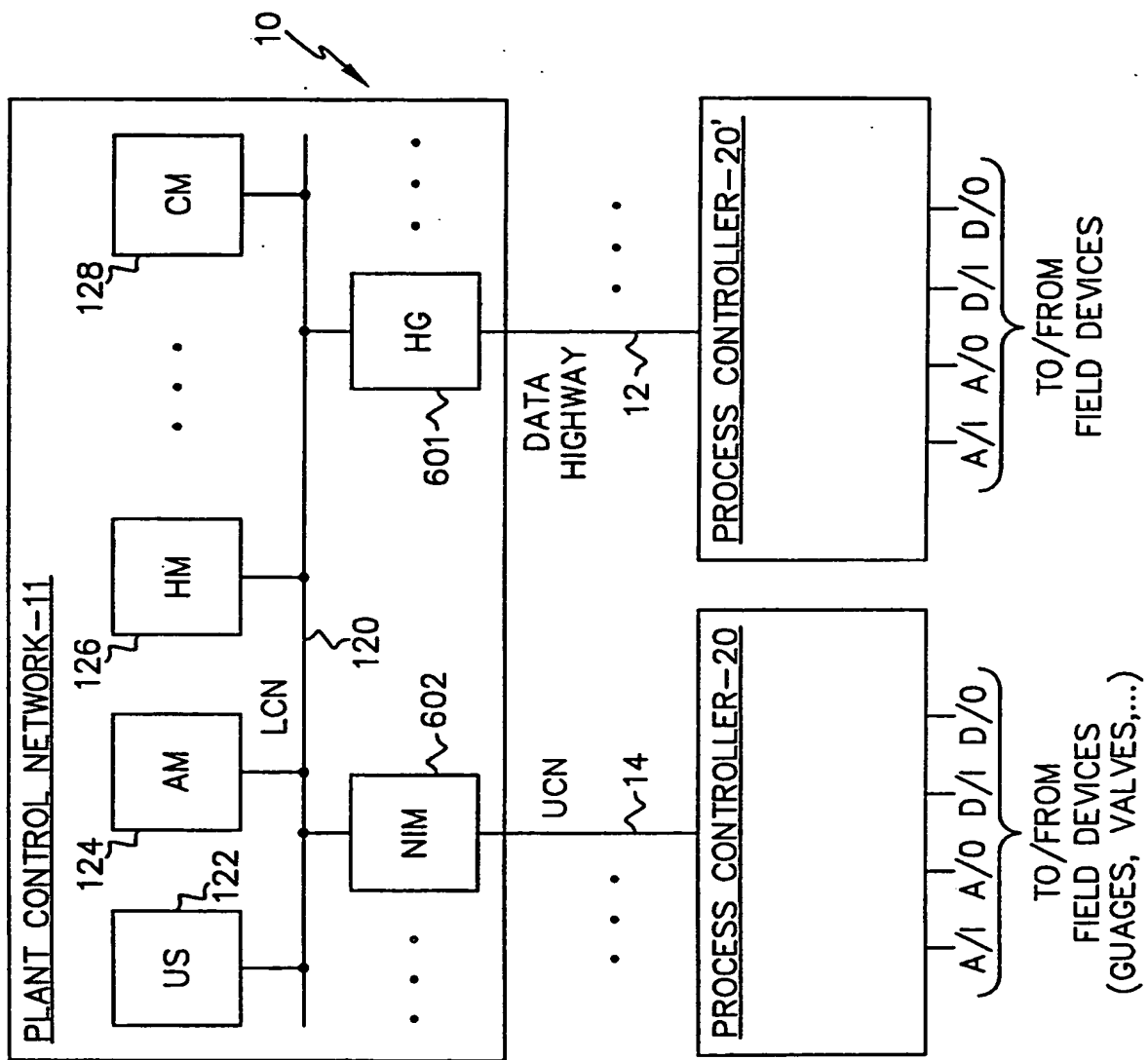


Fig.1

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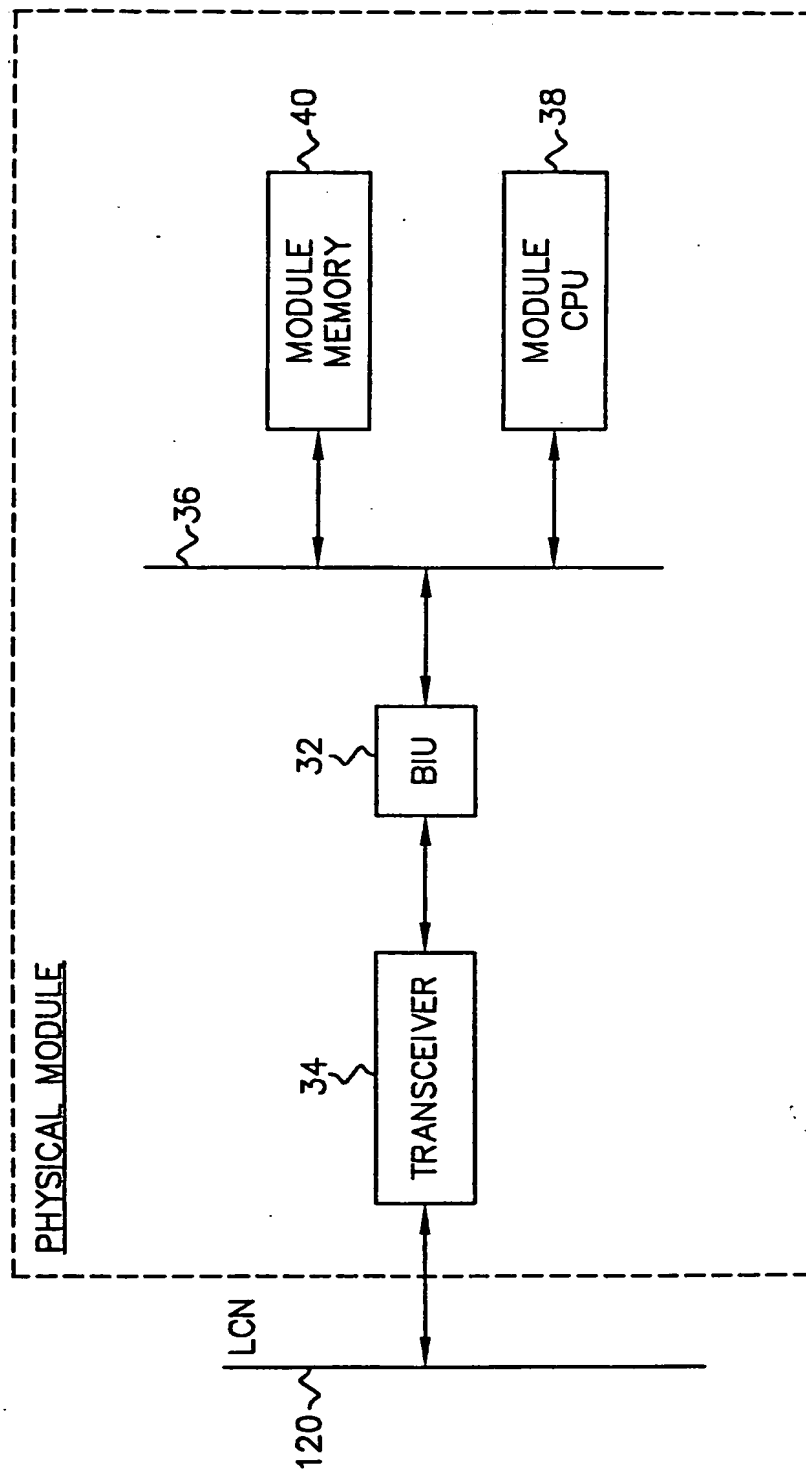


Fig.2

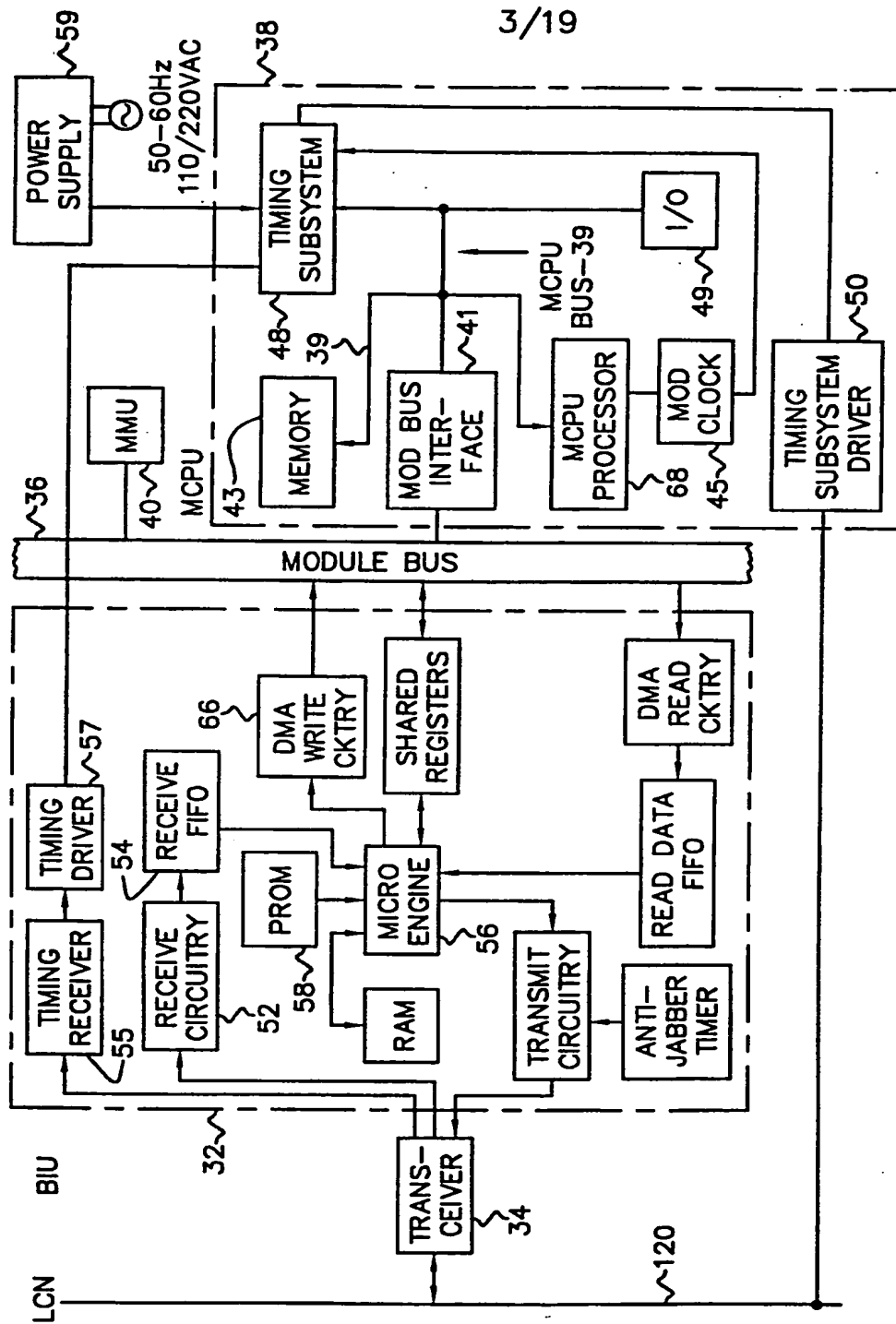
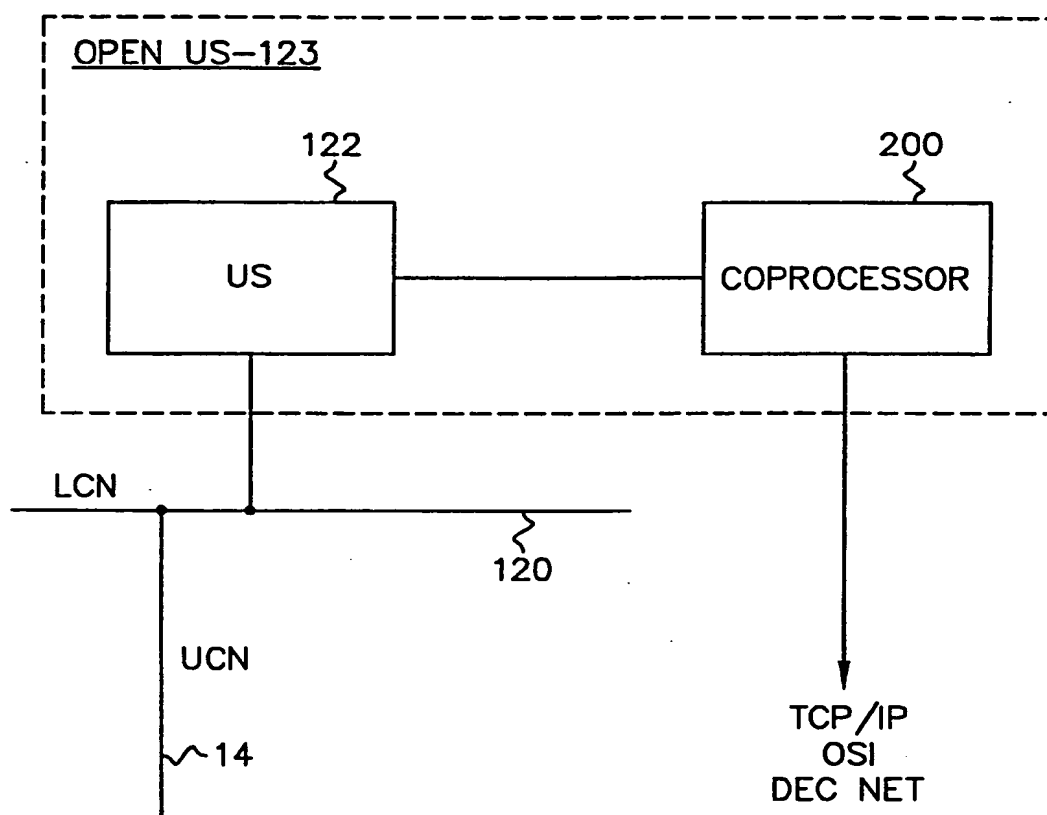


Fig. 3

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*Fig. 4*

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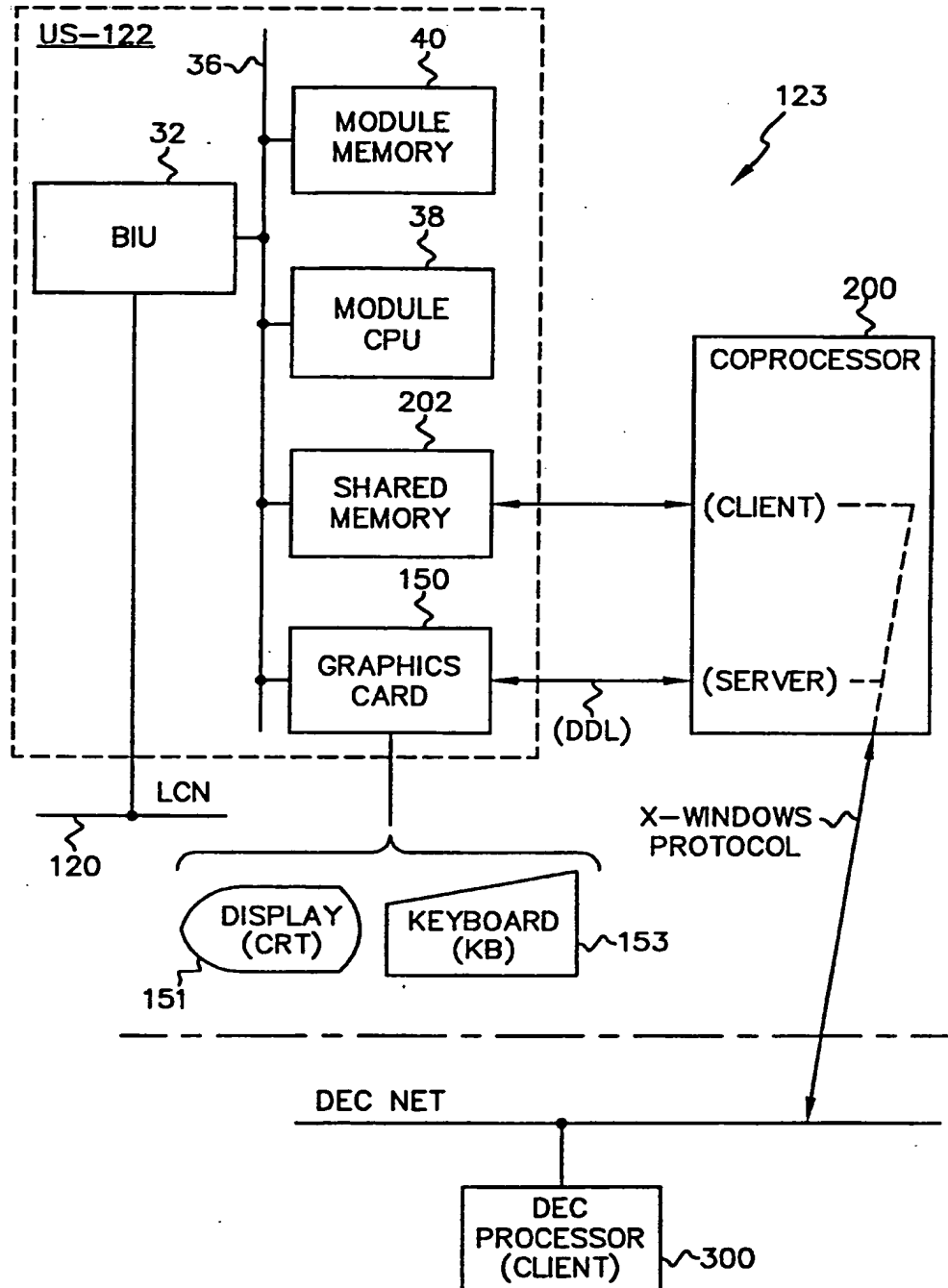


Fig.5

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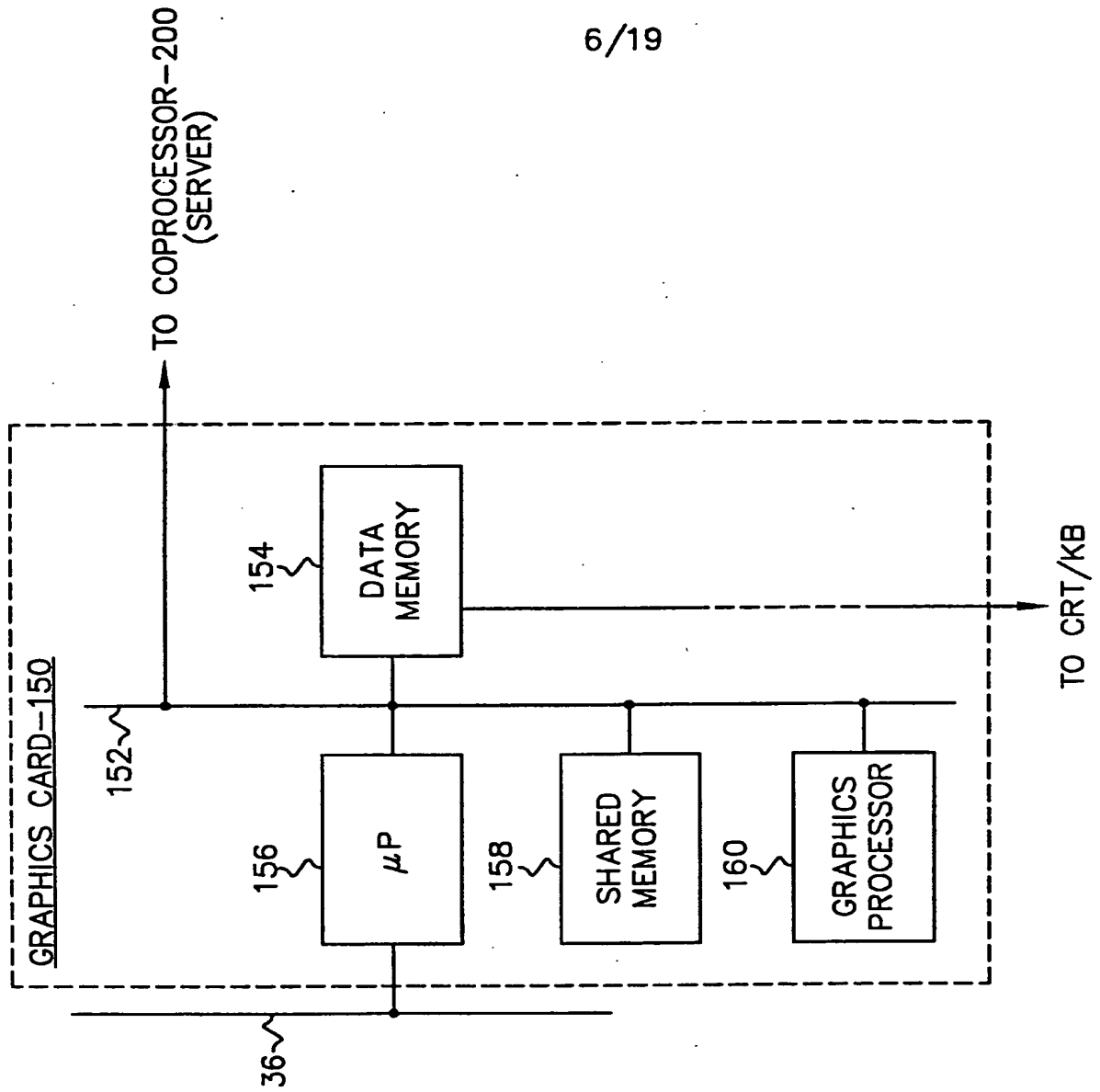


Fig. 6

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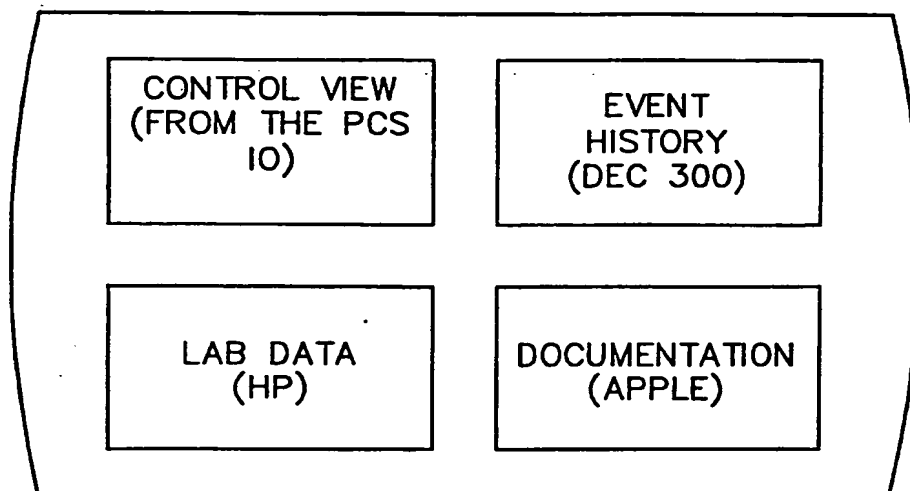


Fig. 7A

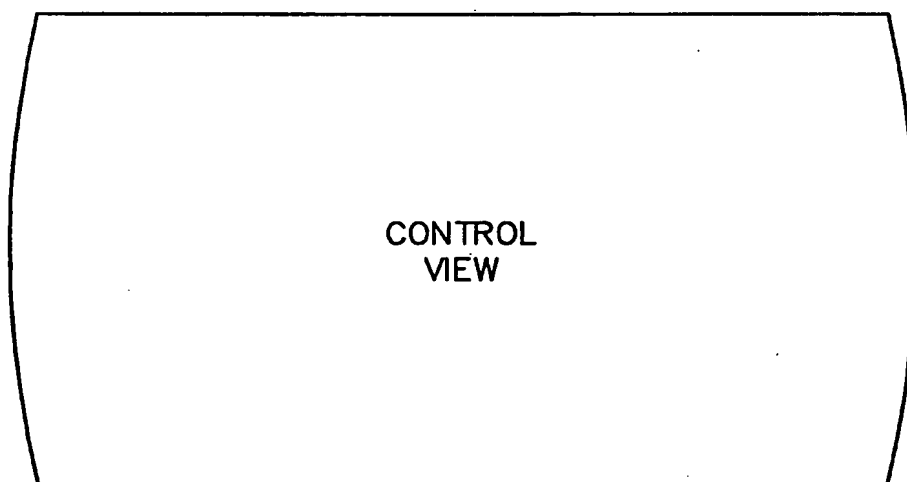


Fig. 7B

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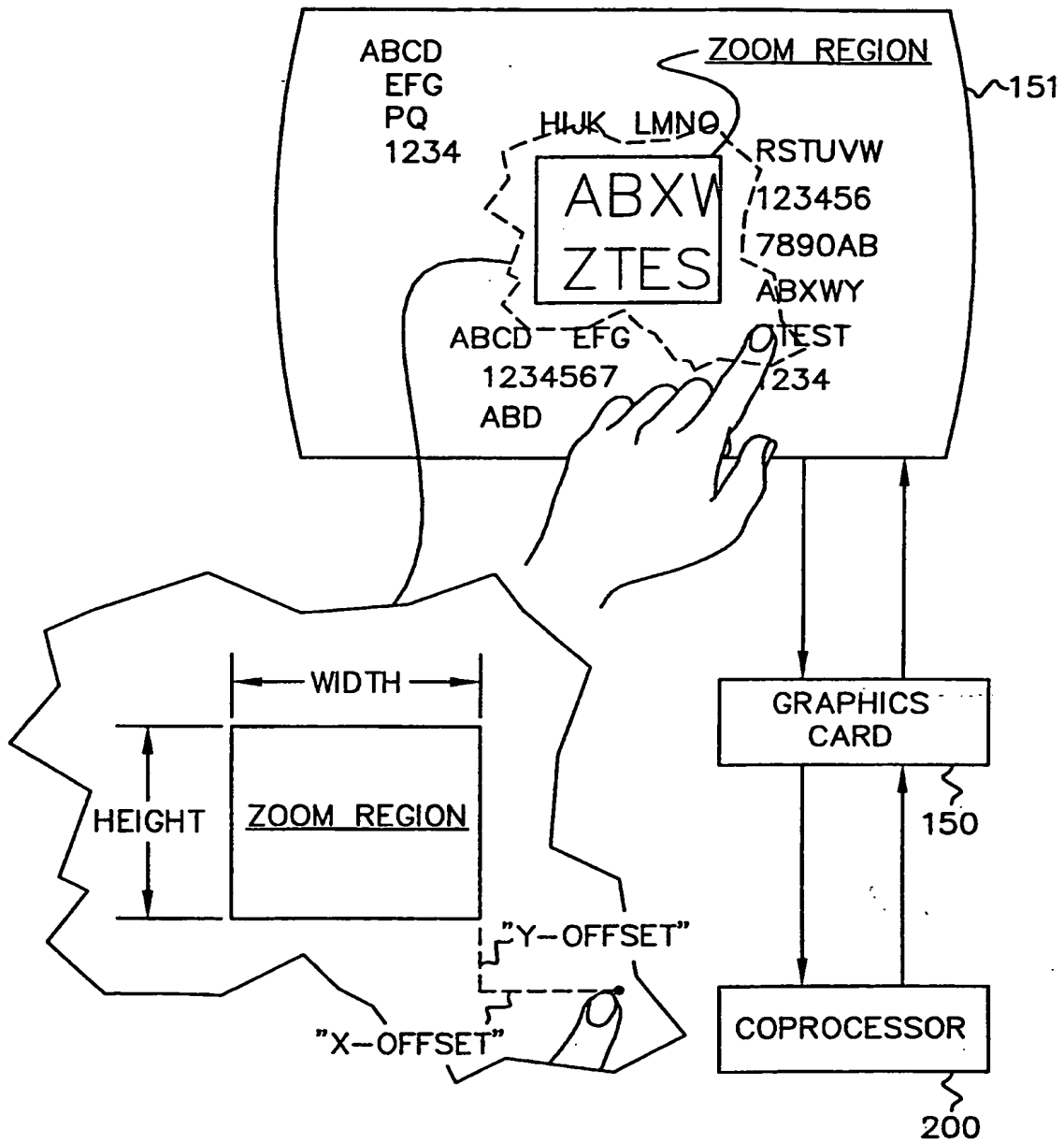
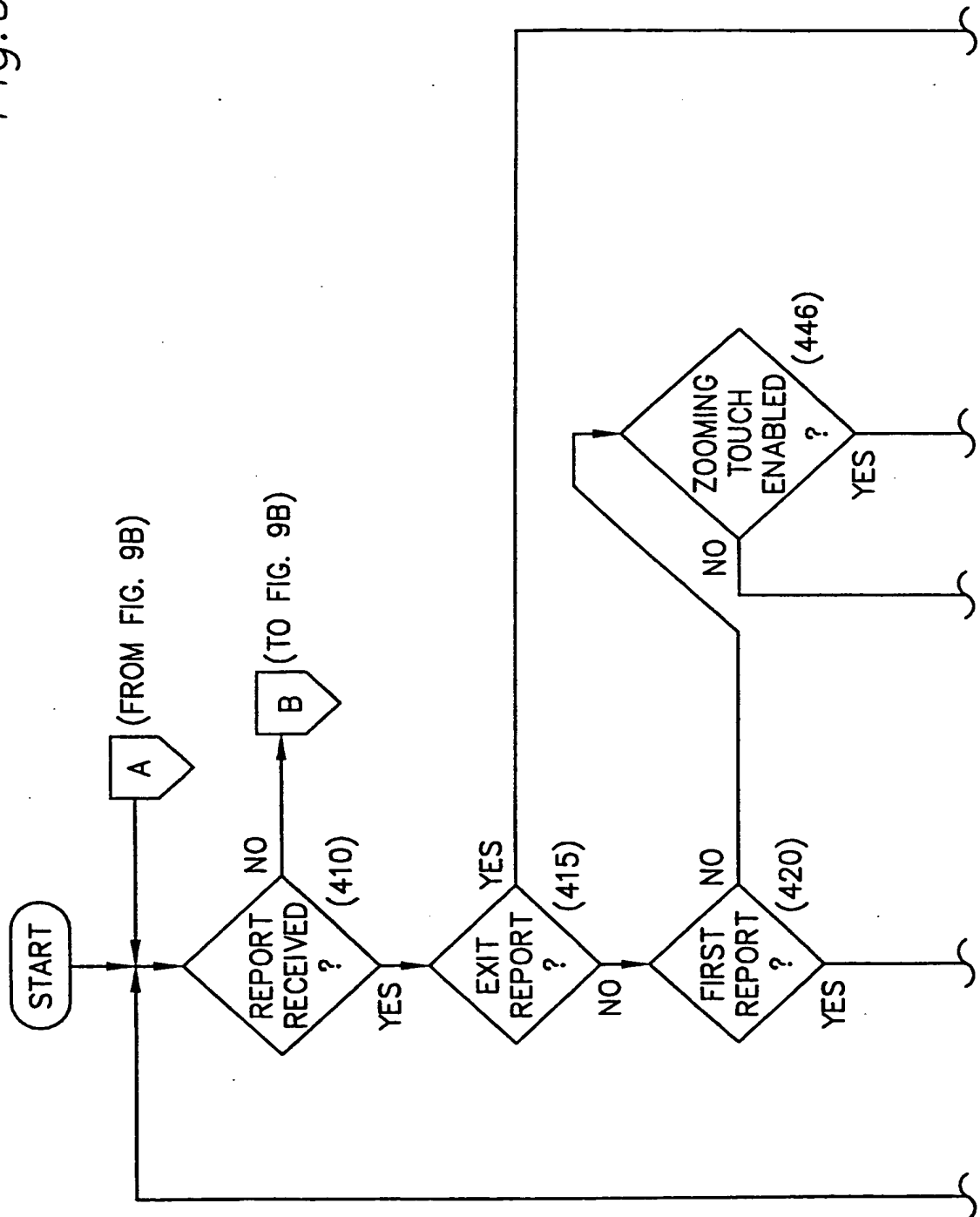
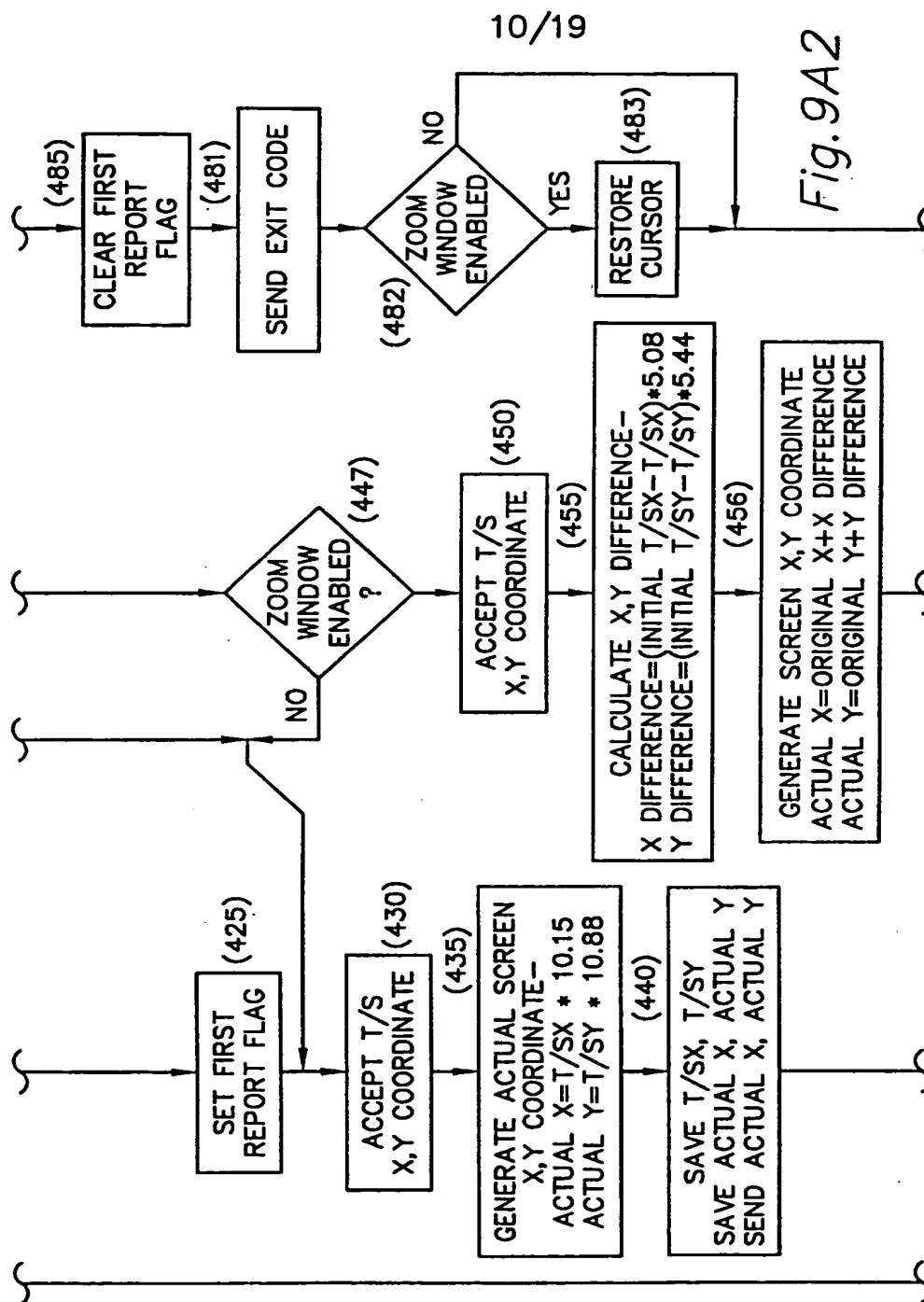


Fig. 8

Fig. 9A1

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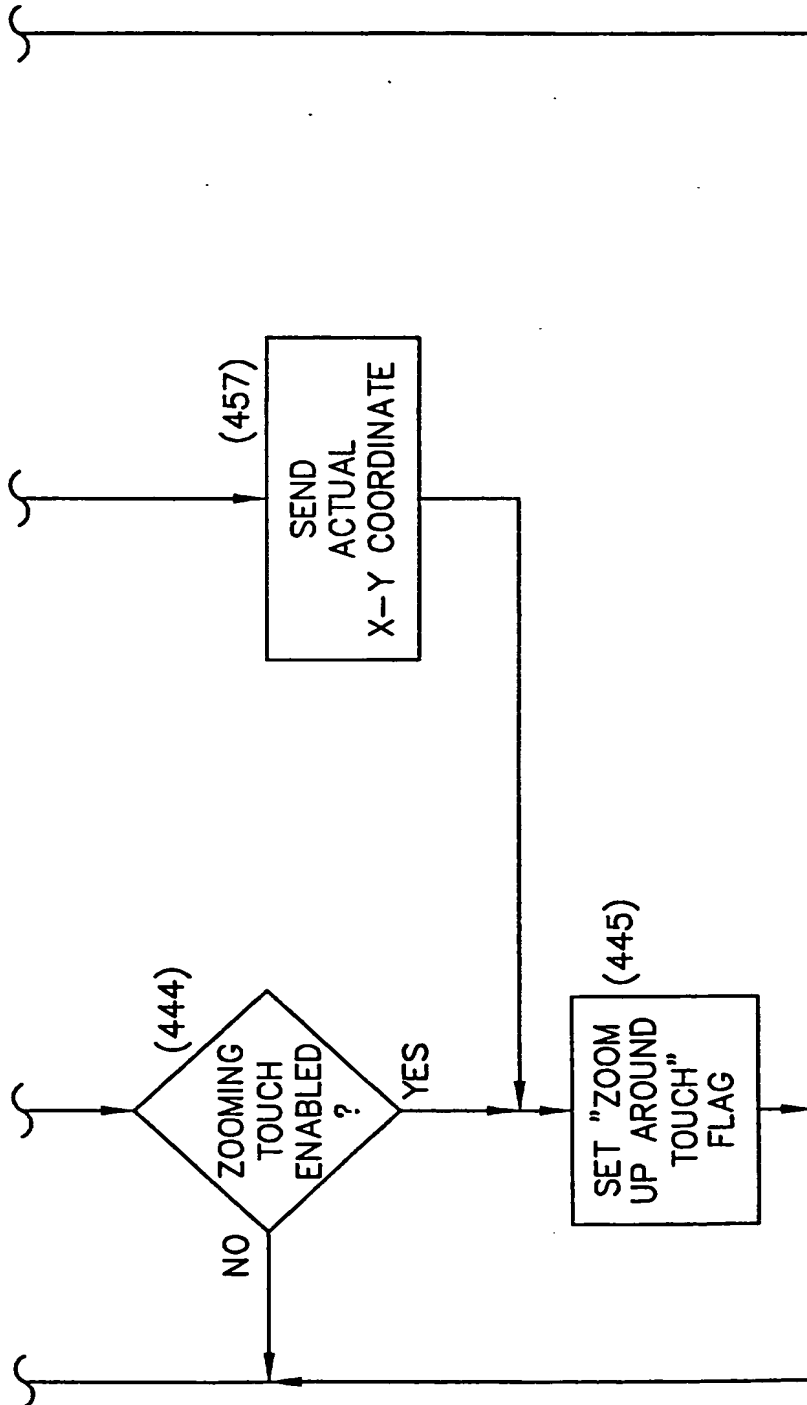


Fig. 9A3

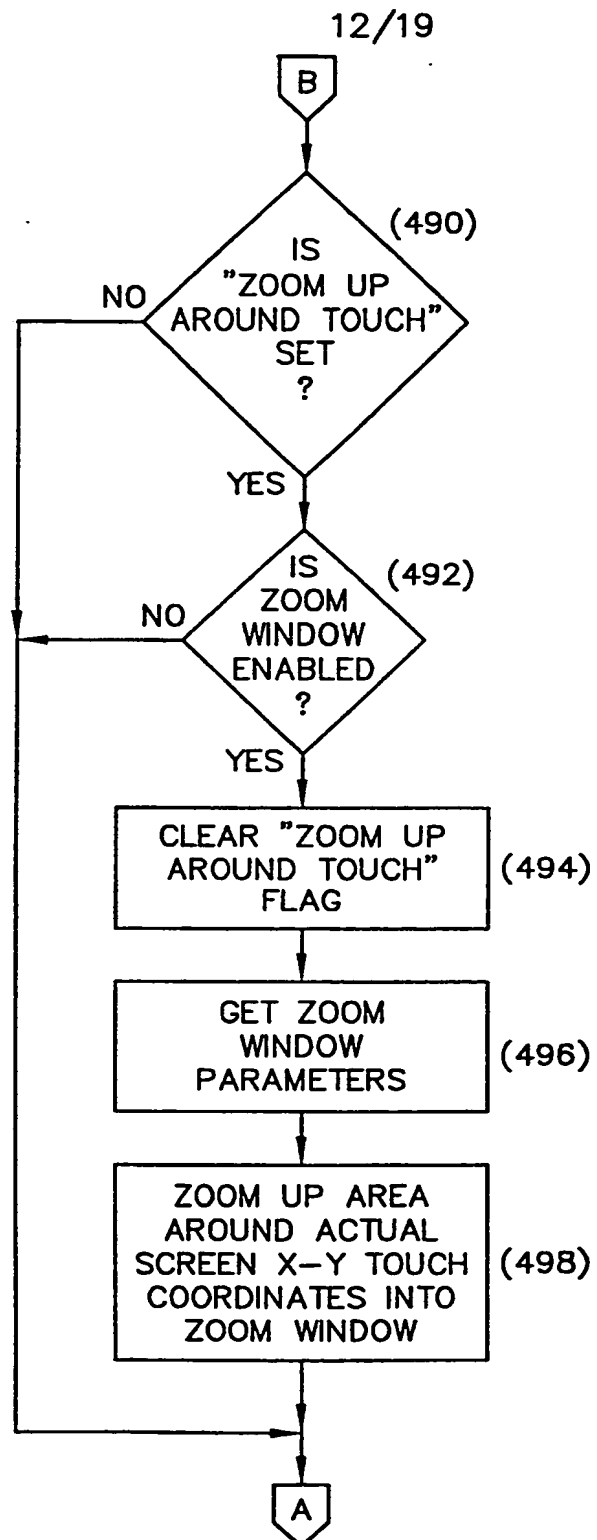


Fig. 9B

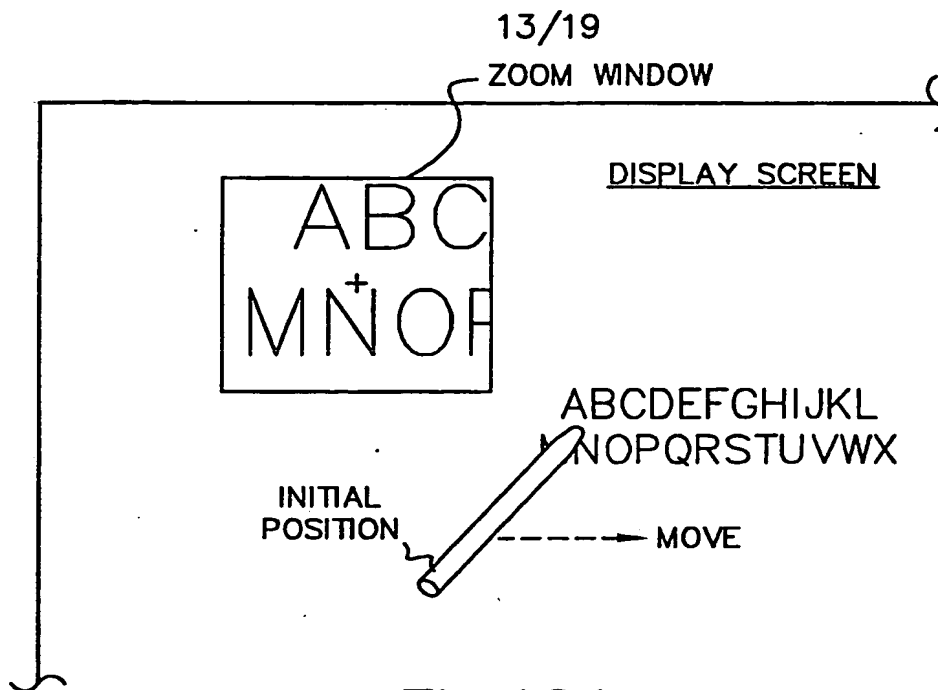


Fig. 10A

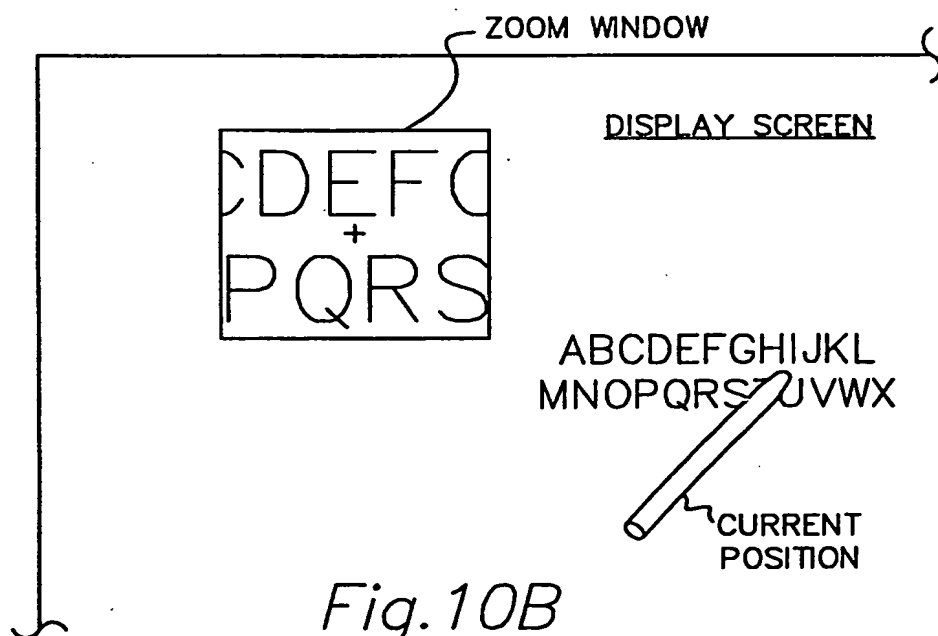


Fig. 10B

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Fig. 11A1

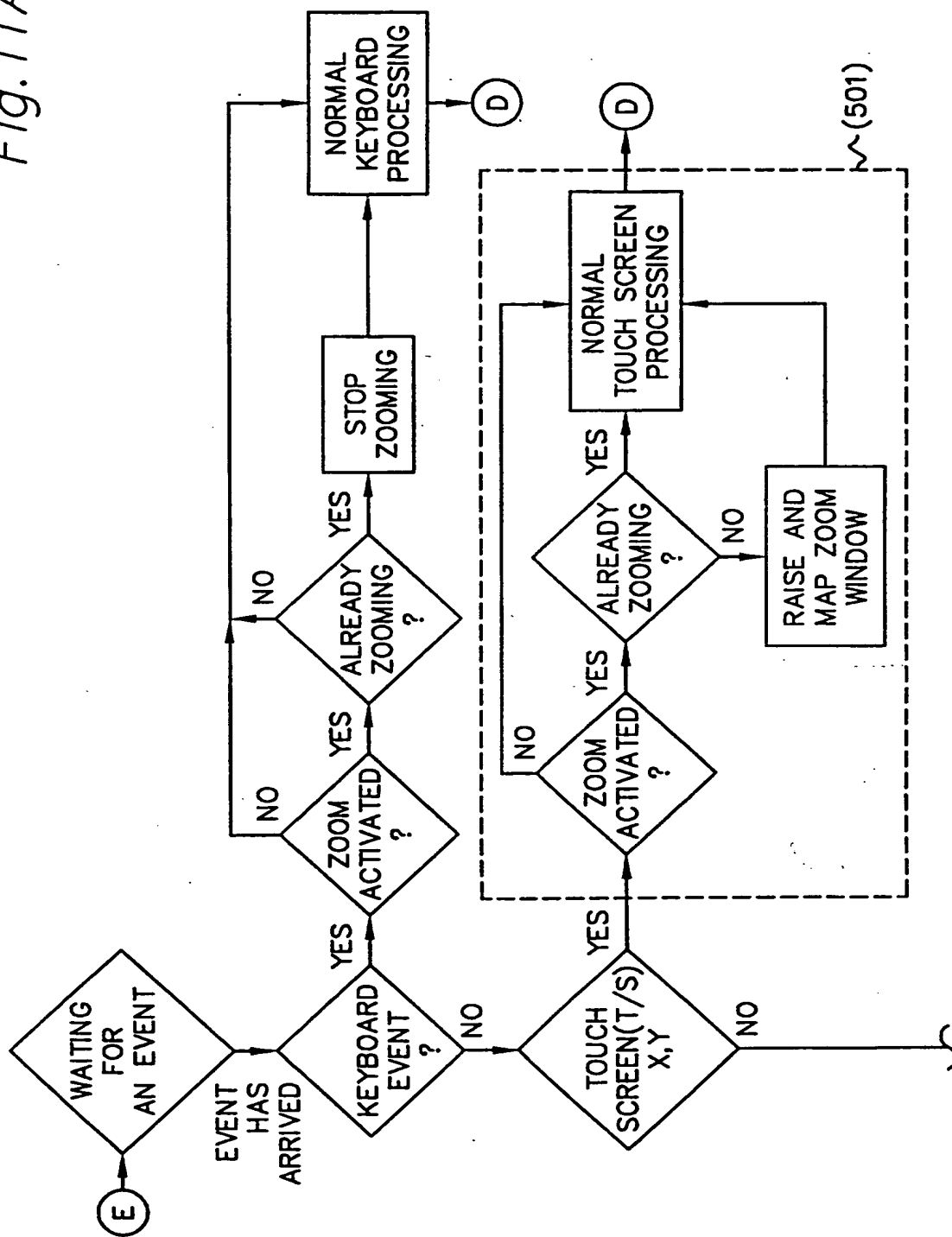
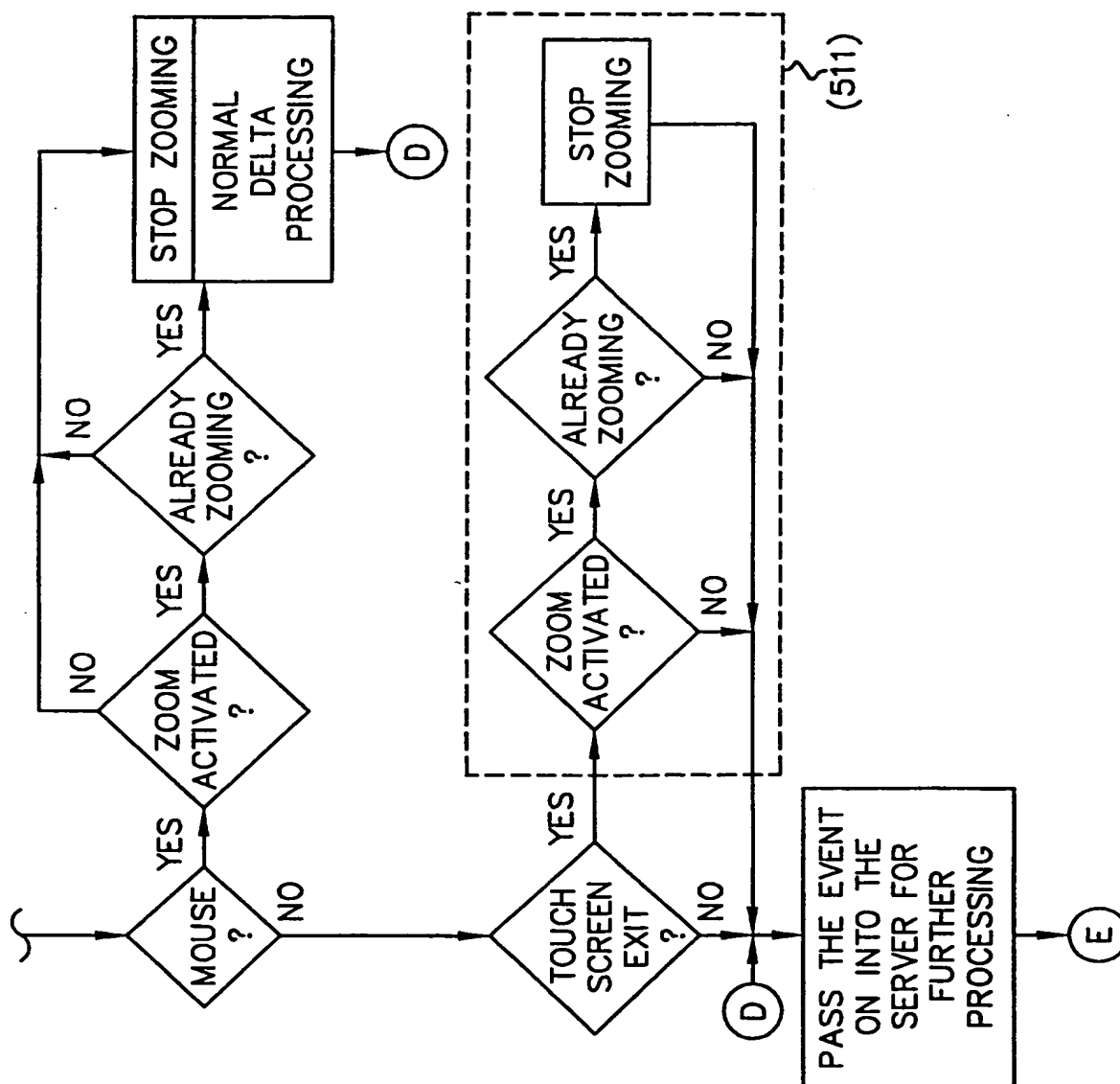


Fig. 11A2

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Fig. 11B1

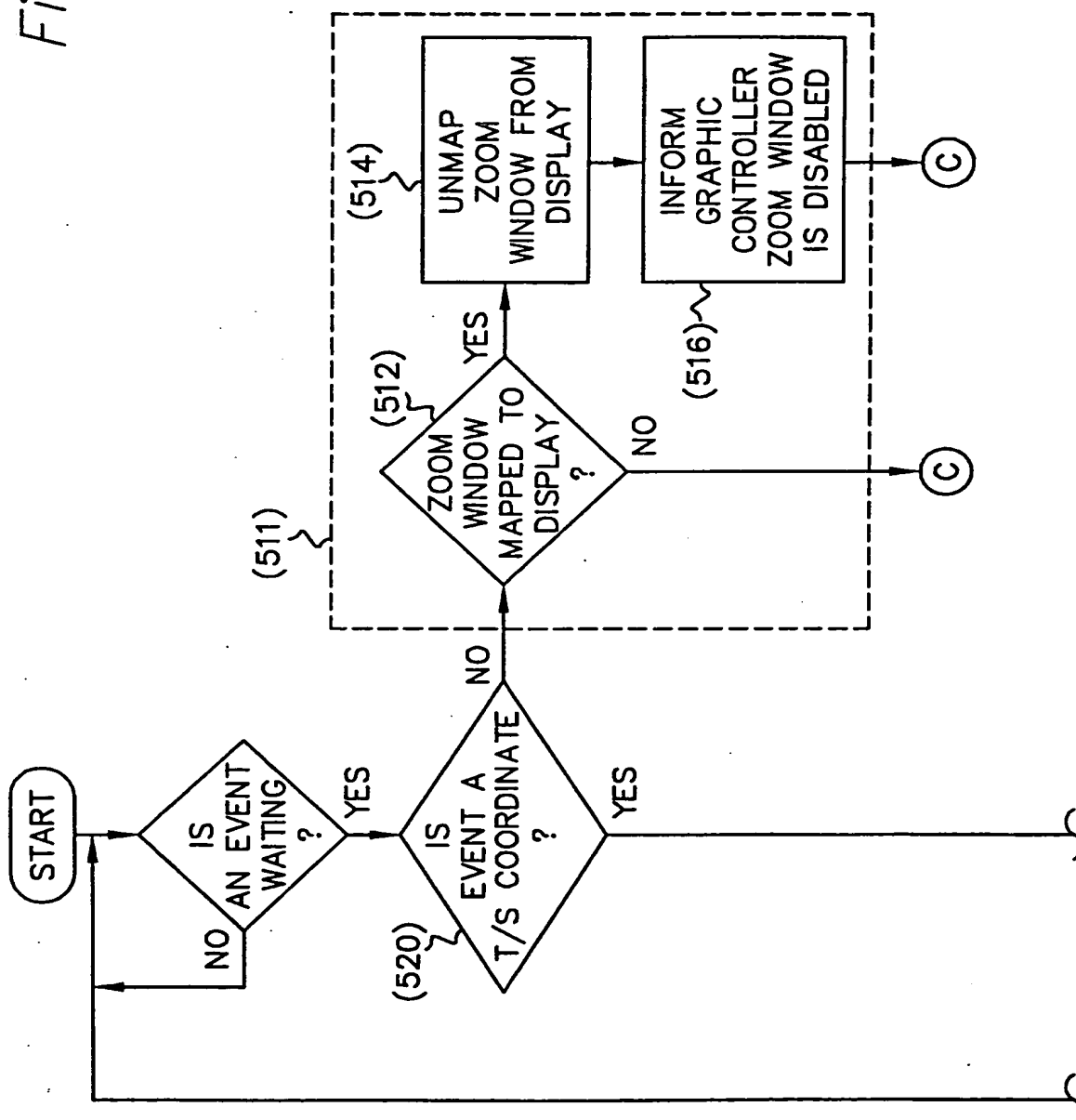
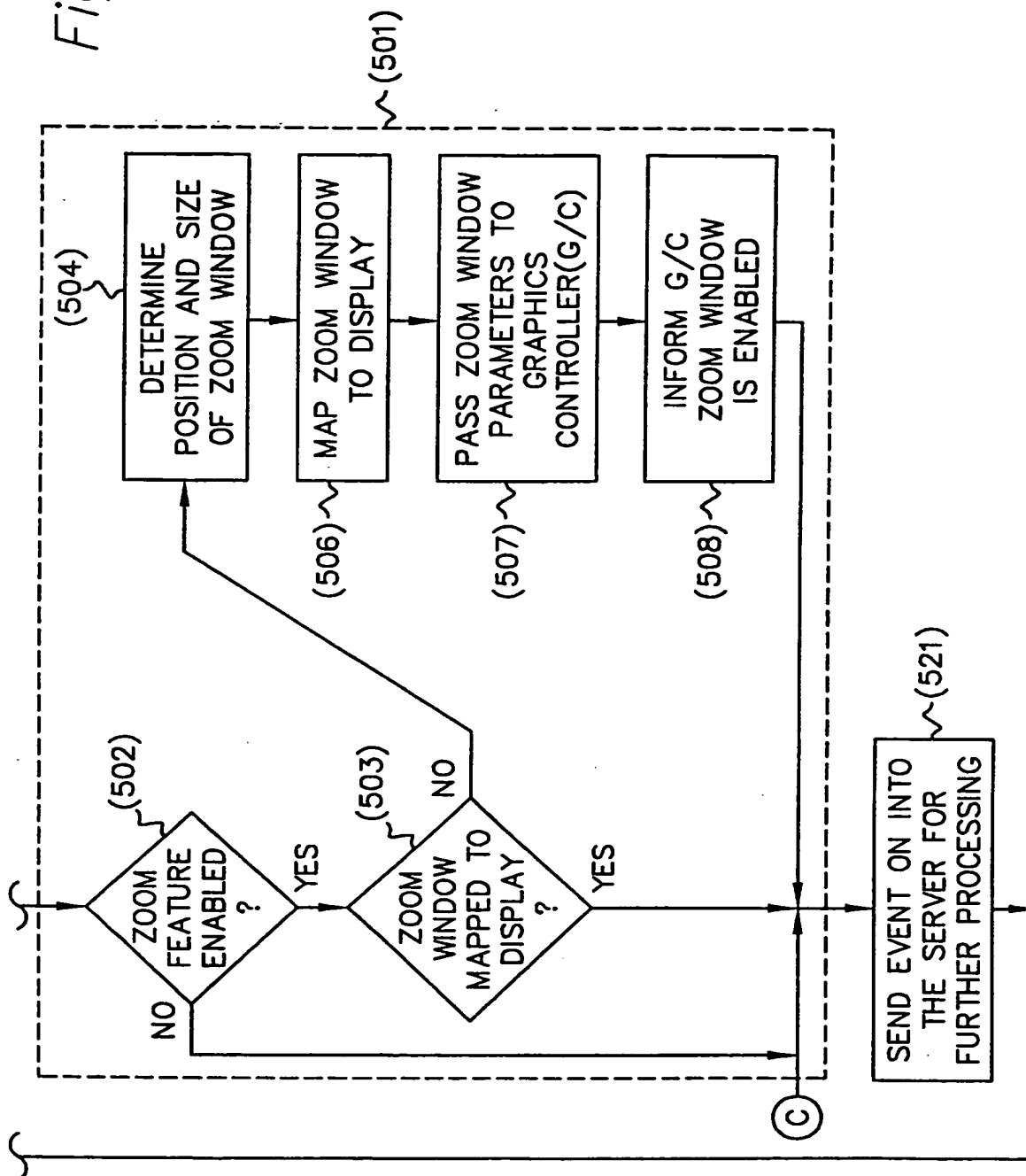
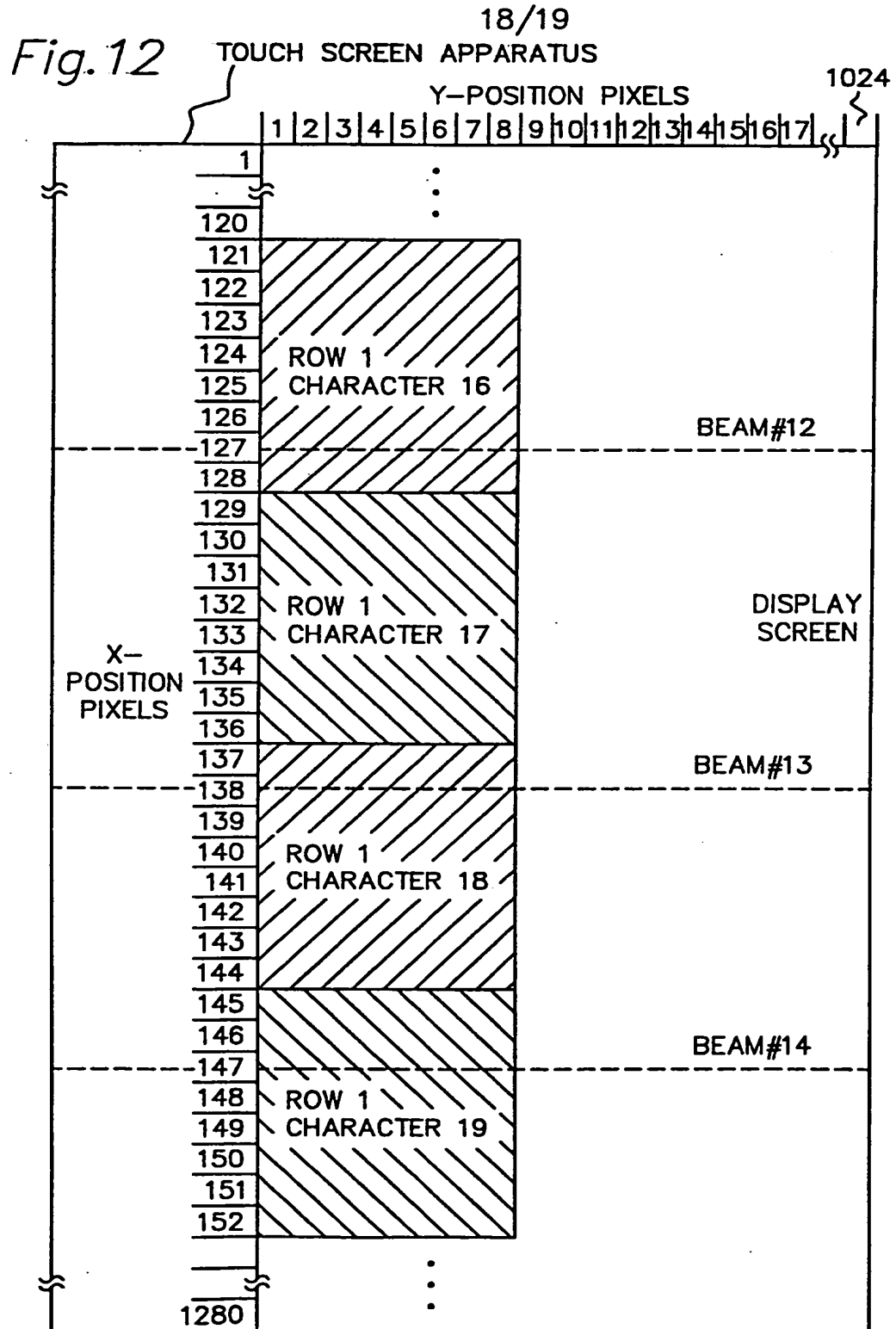


Fig. 11B2

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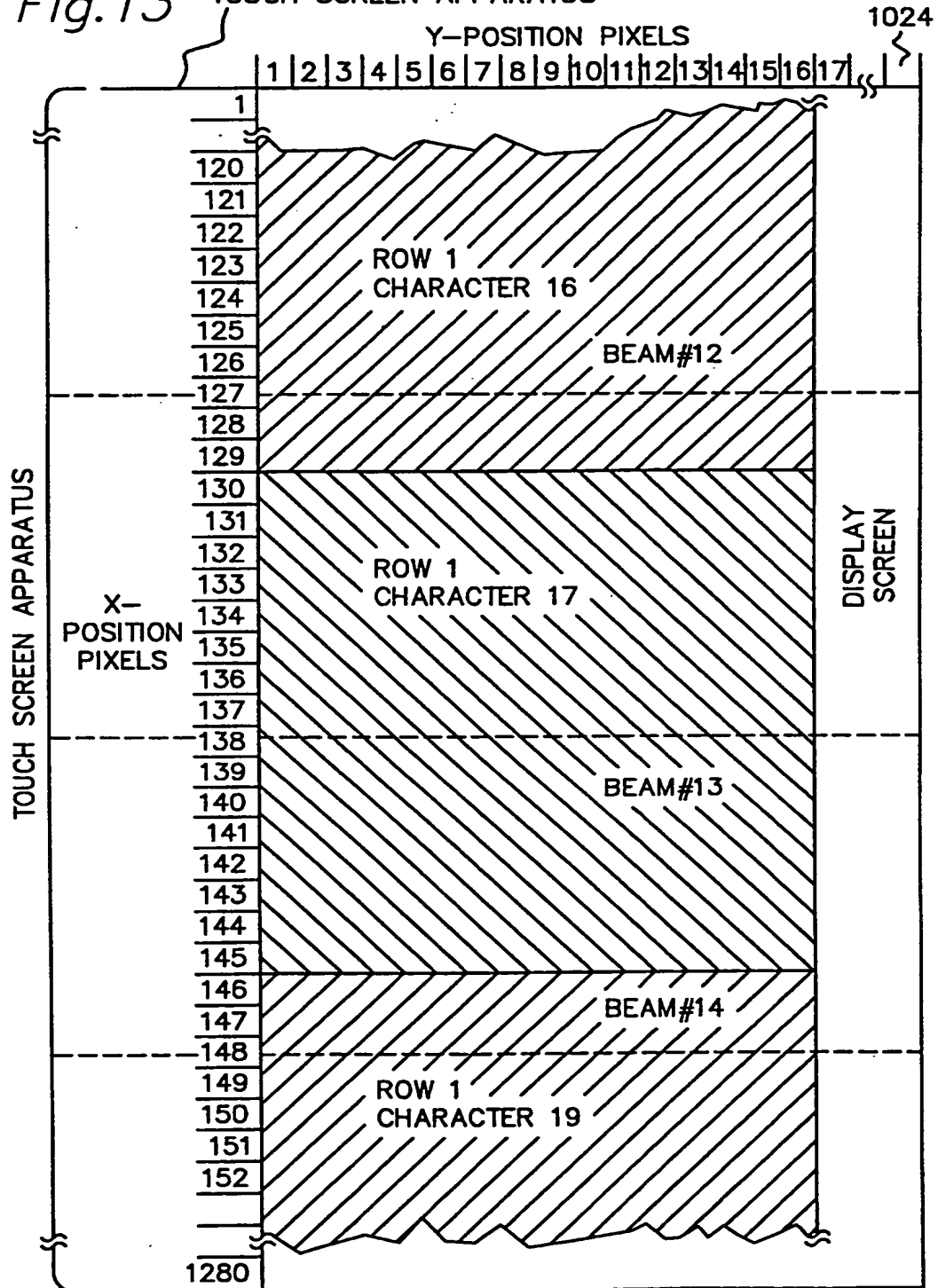




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Fig. 13

TOUCH SCREEN APPARATUS



INTERNATIONAL SEARCH REPORT

In tional Application No

PCT/US 94/06755

A. CLASSIFICATION OF SUBJECT MATTER
IPC 5 G06F3/033

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 5 G06F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	IBM TECHNICAL DISCLOSURE BULLETIN vol. 26, no. 5, October 1983, NEW YORK US pages 2620 - 2621 A.G. COLE AND R. H. RIEKERT 'Touch-sensitive overlay selection repeater' see the whole document ---	1,5,6
A	PATENT ABSTRACTS OF JAPAN vol. 013, no. 271 (P-889)22 June 1989 & JP,A,01 064 062 (HITACHI LTD) 9 March 1989 see abstract --- -/--	1-3

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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- "A" document defining the general state of the art which is not considered to be of particular relevance
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- "&" document member of the same patent family

Date of the actual completion of the international search

17 October 1994

Date of mailing of the international search report

10.11.94

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Fax (+31-70) 340-3016

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Bravo, P

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 94/06755

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	MOTOROLA TECHNICAL DEVELOPMENTS vol. 15 , May 1992 , SCHAUMBURG, ILLINOIS, US pages 49 - 56 B. JOHNSON AND G. RAPPS 'CYCLOPS: a one button alpha-numeric keypad' see page 49, left column, line 36 - right column, line 18; figures 2,3 ----	1,2
A	PATENT ABSTRACTS OF JAPAN vol. 008, no. 211 (P-303)26 September 1984 & JP,A,59 094 135 (MITSUBISHI DENKI KK) 30 May 1984 see abstract ----	1-3
A	EP,A,0 326 751 (SPERRY MARINE INC.) 9 August 1989 see abstract ----	1
P,X	EP,A,0 575 146 (HONEYWELL INC.) 22 December 1993 see the whole document -----	1-10

INTERNATIONAL SEARCH REPORT

Information on patent family members

Int. .onal Application No

PCT/US 94/06755

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		JP-A- 1226020	08-09-89
		JP-B- 6023946	30-03-94
		US-A- 5053758	01-10-91
EP-A-0575146	22-12-93	AU-B- 4013693	23-12-93